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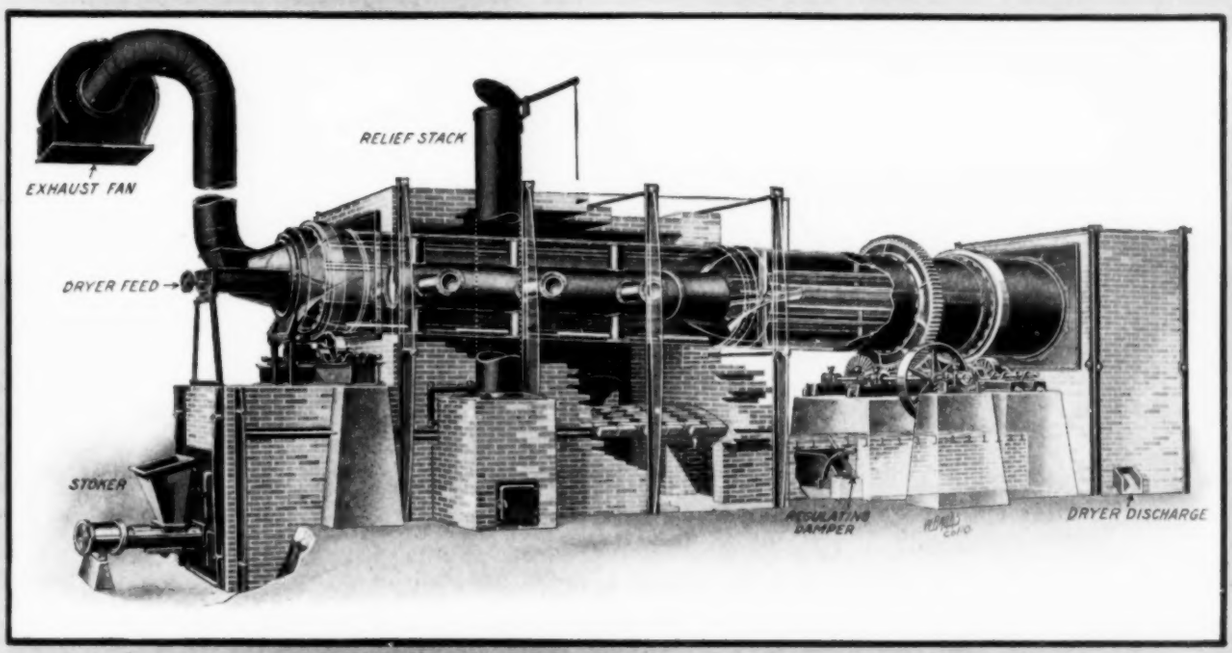
CHEMICAL & METALLURGICAL ENGINEERING



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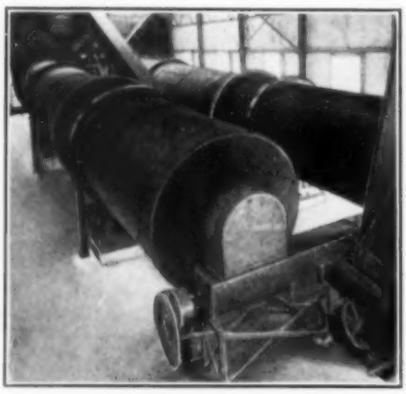

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Volume 24 — New York, April 20, 1921 — Number 16

Wanted—
A Taragometer

ALL YOU have to do is to invent it and develop it and produce and market it successfully, and—there you are! The instrument is sorely needed. Those of our readers who have enjoyed the benefits of a classical education sufficiently to remember their Greek, and any who may be engaged in small-scale roasting and vending of peanuts, and are, like most of their colleagues, themselves Greeks, will readily understand the nature and purpose of the apparatus. It measures noise.

The late JOSEPH PULITIZER, editor and owner of the New York *World*, could not stand noise at all. He was a great editor and a man who, although blind, was gifted with rare mental vision; but noise drove him wild. Being very rich, he had sound-proof rooms constructed in his house for his comfort, and when he traveled he engaged rooms above and below and all around the apartment that he occupied at a hotel. The rest of us have to stand it, but it is not good for all of us. Psychologists are beginning to make records of the effects of raucous, persistent and nerve-racking noises, and the results are worse than expected. They upset the delicate balance of the mind, which is a sensitive apparatus, even among those who exceed in dullness. The riveter may not mind it, because to drive rivets is his chosen calling, but he doesn't have to think much. It is constructive thought that is disturbed by noise; constructive thought and health—mental health. It would be interesting to learn whether boiler-makers and others who live in such rattles are not more addicted to beating their wives than those who dwell in peace. The half-hushed rumble of a city or the distant roar of a waterfall is often soothing, but there are noises, more especially factory noises, that never soothe. Many of them are unnecessary and some of them cost money.

Every bit of unnecessary noise is wasted energy, and when we say unnecessary we mean a strict construction of the adjective. Those who are heavy of wit need emphasis, but if we put it on where it is not needed we not only hurt, we injure. Those of us who engage in thoughtful occupations do not like to be yelled at, and those of us who work with our hands can do better without it.

We know of a laboratory that moved from a noisy street to a quiet place, and as soon as the chemists were freed from the racket and rumble and dust their work improved and their ideas were better. This also holds true of an artisan who needs to use his head at his work. He can't do as well if his ears are constantly recording alarms as he can if given a decent quiet place for his task. Nearly everyone who is sensitive has a little of the PULITZER in him in so far as he is disturbed by noise, while those who are not sensitive cannot make the fine distinctions that we want our best men to make. Noise spoils good work. It is a good thing to bear in mind that we ourselves shall not only do better but also get better work done, if we make less noise. There is too much entropy in noise for it to be wholesome. One of the wisest men of science we know declares that entropy is original sin. We favor the idea.

So let's have the taragometer. It will record in degrees the raucousness, the unpleasantness, the nerve-stretching quality of noises wherever it is installed, and do it quantitatively. It will prevent accidents. Noise distracts, and the distracted brain cannot work.

Our idea of the Garden of Eden is that ADAM ate the forbidden fruit all right just as it is recorded, but that the apple was green and it griped him. Thereupon he lifted up his voice in pain, and a wise PROVIDENCE on hearing the noise determined that with such a racket the Garden ceased to be Paradise, and the result has been duly taught to all of us. Unnecessary noise is entropy, it is original sin, it causes accidents, inhibits good work, and provokes insanity. We need the taragometer.

Strangling Business by
Too Much Organization

LATELY we had a little talk with a Chinese merchant about his business. Production, he said, was a simple problem, but selling in the United States was the very devil. "You can't drive it into the heads of buyers," said he, "that China is farther away than France or Italy." "Send your samples and name your prices, and then I'll tell you whether we will buy or not," they say. This means, it is explained, that deliveries come along nine months later, which is too long a time. Letters take more than a month in transit, and so do packages. "Give me," says the Chinese merchant, "samples of what you want, and the highest price at which the goods made in China will interest you. Then I will cable you my figure, which may be a quarter or even half off your price, if you name me present costs; and I will guarantee quality and insure delivery." "We don't do business that way," say the buyers. "We refuse to give up our patterns, and we demand deliveries three weeks after the cable order." Then the Chinese merchant goes to the head of the firm, shows what he can do, and how he does it, and the merchant understands. He appreciates the big killing to be made with Chinese goods, and sends for the buyer, who listens again to the story already told him, but the buyer repeats the statement that "that isn't the way we do business." He or she doesn't know any other way, because no matter how often it is explained "it isn't done."

The merchant is in the hands of his buyers, of whom so many are wooden-headed that he does not know how to get better ones, and time and again orders that are desired are lost for the very reason we have given.

The old gentleman who understands and wants to buy

is himself to blame. He has overorganized his establishment. He has so firmly fixed "the way we do business" that it has become gospel among his employees. It is even more stolidly established than Chinese tradition. He has killed initiative among his buyers so that a person who thinks for himself does not want the job, and the wooden-heads increase and multiply under him.

If we want good work done we must make it interesting; otherwise we can't get competent and high-class men and women to stay on the job and do good work. If we overorganize our business we are bound, in the long run, to surround ourselves with dullards.

Some Steel Price Comparisons

SUBSTANTIALLY identical prices, as between the United States Steel Corporation and the independent steel producers, have developed again, and comparison of prices at various times is befitting. The course of steel prices may be reviewed briefly. The general substitution of mild or soft steel for wrought iron was completed before the end of the industrial depression of 1893-98, and by a combination of rich Mesabi ores, low wages and economies generally very low prices ruled in 1897 and 1898. Afterward there were various ups and downs and at the end of 1914 the lowest prices since 1898 were reached. Leaner ores were then used than in 1898 and wages were about 50 per cent higher, but manufacturing processes were much better.

During the war steel prices advanced and after the entrance of the United States the advances were spectacular. Then came Government price control. Dec. 13, 1918, slight reductions were made by the mills, as a step in deflation, and through the instrumentality of Secretary REDFIELD'S Industrial Board further reductions became effective March 21, 1919. From then until last week the United States Steel Corporation adhered to the Industrial Board prices. The independents at first cut those prices, until some time in June, 1919, and late in the year they advanced over those prices, while in 1920 there was a wildly advancing market on the part of the independents, with continued expectation on their part that the Steel Corporation would advance its prices. Such expectations were disappointed, and by the end of 1920 the independents were back to the Industrial Board or Steel Corporation prices. During January of this year there was a uniform market, while in February the independents began cutting. Early in April the independent market firmed up somewhat and then, effective April 13, the Steel Corporation made certain reductions in its prices, whereby the independents and the Steel Corporation are again at the same level.

Using a weighted average of the important steel products according to their tonnage importance, including bars, shapes, plates, pipe, wire, sheets and tin plate, a fairly complete summary of steel price movements can be made in small compass, as given below:

Ten-year average, 1904-1913	$ 36.00
Five-year average, 1909-1913	34.00
Year 1913	34.50
Dec. 31, 1914	28.50
High, July 1, 1917	114.00
Government control	76.00
Dec. 13, 1918	72.00
March 21, 1919	65.00
Independent high, 1920	93.00
Dec. 31, 1920	65.00
Independent low, March 1, 1921	57.50
Present general market	60.00

In price comparisons in general of late, various bases for a pre-war level have been taken, and in the foregoing presentation several are therefore given for steel. The figures represent prices in dollars per net ton as a weighted average of the finished products just mentioned.

Pre-war averages are much the same, whatever period of years be taken as a basis, but pre-war high and low points are a different thing. We are not looking now for pre-war prices, for neither wages nor freight rates will get back to pre-war levels, but there is room for argument as to whether we should look for prices in relation to pre-war averages or prices in relation to pre-war low points.

Taking $35 as a mean of pre-war averages, the present finished steel market is 71 per cent above that basis. On the other hand, it is 35 per cent below the high prices of independents in 1920, not the highest prices charged on small lots for prompt shipment, but the prices obtained on moderate sized lots for ordinary deliveries. It is 21 per cent below "Government prices" and 47 per cent under the very fancy prices ruling just before the Government undertook to take control as a necessary war measure.

Can we compare the 71 per cent excess in steel prices over the pre-war average with the relations that other commodities show to their pre-war averages? Some undertake to do so, but the showing depends simply upon what commodities are taken. Tin, copper, antimony, aluminum, lead and zinc are all below their pre-war averages. According to a statement prepared by the Bankers Economic Service, rubber, compared with its average Feb. 1 in each of the five pre-war years, is at 18 per cent, or less than one-fifth price, hides are at 62 per cent and coffee (wholesale) is at 63 per cent. Brick and lumber, on the other hand, are at more than double price, 264 per cent and 222 per cent respectively, while cement is set at 317 per cent.

Steel, apparently, would search in vain outside the industry for a standard. The industry will have to develop its price level from within.

Necessary Operating Conditions To Avoid Smoke Damage

JUDGE JOHNSON'S final decree in the Salt Lake Valley smoke suit, now at hand, impresses one as being quite unusual in that it apparently is able to point the way whereby smelters can operate with no interference to their development and future improvement and yet establish no nuisance to the neighboring residents.

Time was when any rancher, on finding his crops marked in any way or his stock drooping, or for that matter, if his own head ached, would sniff the air for smoke and join with his neighbors to sue for damages or to enjoin operations at any smelter within twenty-five miles. All damage was smoke damage. Many fanciful claims were advanced by the plaintiffs, and as we know now, almost as fanciful defenses set up. A vast amount of human energy and good feeling was spoiled in these squabbles; the operating companies upon which the bulk of the expense rested have spent sums of money easily aggregating millions in fighting unwarranted claims, in settling just claims, and in purchasing easements or damaged property. A half dozen or more plants stopped operations rather than face what seemed to be continuous guerilla warfare; their losses ran into millions more.

In those days arsenic, lead and sulphuric acid were thought to be the chief culprits; consequently courts decreed that extensive dust chambers, bag houses and flue systems must be installed to catch all but traces of these substances. Furthermore, the total tonnage of sulphur eliminated daily was usually specified, thus strictly limiting the amount of ore smelted in one place. Such stipulations, together with others limiting the SO_2 concentration in main stack gases, gave evidence that courts recognized the potential danger of that gas long before operating companies would admit the fact. Fortunately for the smelters, big dust chambers and long flues required draft, and draft was easiest had by high chimneys. High chimneys allowed the smoke to dilute itself in the atmosphere before again reaching the ground, and the real danger was thus inadvertently minimized.

Investigations of high scientific merit, continued during the past ten years and summarized from time to time in these columns, have made it plain that SO_2 would produce characteristic markings on the foliage of growing plants. This was something of a poser to those managers who had deluded themselves with thinking that if their smelter stacks showed no smoke—no visible fume, unconsumed carbon, or condensing vapors—then no damage would result. Or at least no damage would be ascribed by residents to smelter smoke. A further shock was due them when it was finally established that 1 part SO_2 per million for three hours would under optimum conditions produce foliar markings, and as little as 1.3 parts per million would do the same in one hour. In view of the fact that prolonged puffs of smoke are likely to sweep down at any time, it seemed that it would not be safe to operate a smelter so that the SO_2 content in the air of the so-called smoke zone would average more than 0.3 part per million—a dilution so high that operating officials freely declared it to be impossible of attainment. They almost fell into the error of denying the possibility of SO_2 damage, and the attempt to purchase peace by a discreet claim agent.

The more far-seeing and stout hearted, however, viewed the problem of dilution as one which could be solved. Theoretically, of course, it could be done by enormously high stacks or infinitely hot gas. The former was economically impossible, the latter would defeat the aims of metallurgy. A compromise, joining the correct chimney with a proper temperature above atmospheric, was evidently an engineering problem strictly, capable of definite solution when the necessary data had been collected.

The latest decree is therefore unique in several ways. It was postponed until the engineering solution had been found, put into operation, and finally investigated and found satisfactory by an independent commissioner. It may therefore be accepted, not only by courts as a precedent, but by smelter officials as a rule by which they can avoid damage to surrounding vegetation.

Given a modern smelter, with correct provision against leakage of smoke in the buildings or from the flue system, the principal precaution is that the dust-free gases be discharged from the main stack at a correct temperature above the atmosphere. In this decree no stipulation is made as to the amount of ore which may be smelted, the average sulphur on the charge, or the tons of sulphur eliminated. No reservation is taken as to the concentration of SO_2 in the stack gases, nor the method of clearing them of solids; in fact, it may be remarked that probably for the first time the Cottrell system has been formally adjudged to be a satisfactory medium for collecting dust, fume and sulphuric acid, equal to the bag house.

In other words, while the SO_2 concentration in the stack gases, the chimney height, the topography, wind prevalence and general weather conditions all have their influence, it may now be taken as quite probable that foliar markings during the growing season may be entirely eliminated, no nuisance established in the eyes of the court, if the smelter management pay proper attention to discharging the gas during the day time at a correct temperature. What that correct temperature difference is may be established with relative certainty and at less than the cost of one damaged crop by merely studying the relation between average field concentrations, stack concentrations and stack temperatures. For the present Murray plant the figure happens to be 75 deg. C.

A General and Particular Confession of Pharmaceutical Fault

EVERY time we mention rats we get into trouble. Years ago we ventured to propose the tanning and use of rat skins as a means of getting rid of the pests, and the correspondence which followed from persons ambitious to profit by our suggestion included letters from a young man eager to enter the rat business, the secretary of a Woman's Vocational Association willing to sell tanned hides but unwilling to catch or touch rats, and a hardy son of toil who threatened to send rat skins to the office. It nearly upset us. We had a "scientific management" man in the establishment then who figured up inches of space and tabulated everything. It messed up his tables. It took us months to get over it, and the only compensation was Dr. ROEBER'S chuckle of delight over the episode.

Lately we mentioned, in an editorial on the chemistry of olfactics, a note from the London *Daily Mail* that rhodium was a wonderful lure for rats, and, being botanically ignorant, we tried to find a little amusement in quoting an eminent electrochemist to the effect that if the rodents liked rhodium they would probably take to platinum, and that they might be used to find it, for LORD knows it is scarce enough!

Now we confess ignorance for ourselves and for our entire staff in this respect. Probably we should have a department of pharmaceutical chemistry, but we haven't. Apparently, however, we have friends who are more familiar with botany and pharmacy than we are, and about a dozen of them have written to chide us for our ignorance. These letters make us humble and we confess it openly. They are printed elsewhere in this issue and will afford the reader a smile at our expense.

We do not know the name or address of the printer or the writer of the article in the London *Daily Mail*, but if Mr. ANDREWS can find them for us we promise the printer a good free-smoking hand-made Havana filler cigar, and a Flor de Convolvulus Scoparius to the author. There is a crumb of comfort for us in Mr. CRAIG'S note that rodent bait is not really and truly oil of rhodium after all, but we make no claim for a bill of wisdom in the assertion. The real mistake was ours, rhodium is a plant or a shrub or a tree as well as a metal and we did not know it.

Readers' Views and Comments

Rhodium for Rodents

To the Editor of Chemical & Metallurgical Engineering

SIR:—Anent your editorial on olfactics: Rhodium is rosewood. See "Condensed Chemical Dictionary," page 404. The name was in use before the metal rhodium was known. D. D. BEROLZHEIMER.

New York, N. Y.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 502, of the March 23, 1921, number of CHEM & MET., under the heading, "The Chemistry of Olfactics," at the end of the third paragraph you close with the following: "We wonder what the London writer wrote that the printer mistook for rhodium!"

It is perhaps not to be wondered at that an ex-president of the Electrochemical Society thought that a metal was meant and that perhaps a rat might be trained to track down any missing articles of rhodium or platinum, but I am sure that what the London writer meant and wrote was rhodium, which is the wood of *Convolvulus scoparius*, or rosewood. From this a volatile oil is obtained which is used as a bait for some animals. You will find this on page 404 of the "Condensed Chemical Dictionary." I think that you owe the unknown London writer a cigar. A. B. ANDREWS.

Lewiston, Me.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—You are puzzled to know what is "oil of rhodium," on which rats (rodents) are so keen. Oil of rhodium or rodium was a nostrum, very familiar to youngsters before the civil war. It was used to bait fish as well as rats; all that was necessary was to buy a small—very small—phial of the widely advertised stuff at a drug store for an exorbitant price and use a drop of it on the fish-hook. I do not remember anything more about it except that my experience with it, as a small boy, led me to believe that it did not attract the fish. W. GEORGE WARING.

Webb City, Mo.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Some cynical person has said that the mishaps of our friends are never wholly unpleasant to us, and I must confess that I could not repress a chuckle after reading the interesting editorial entitled, "The Chemistry of Olfactics," which appeared on page 502 of your issue of March 23.

Did no guardian angel whisper to you to look in the dictionary to see whether there were not some kind of rhodium other than that with which you are familiar before you let go those flippant remarks about the use of rats in prospecting?

The story of the geologist reminds me of an equally famous one about the sea captain who could always tell the location of his ship by the taste of the earth that came up adhering to the bottom of the lead. One night when he was nearly asleep in his bunk the first mate thought to play a trick on him and so stuck the end of the lead into a flower pot that they had on board and then presented it to the captain to taste. To his great surprise, the captain leaped from his bunk and shouted aloud: "Nantucket is sunk and we are right over Ma Jones' garden!" The story about the blind deaf-mute does not stagger my credulity, because when I lived in China I was able to apply a somewhat similar system to my Chinese servants, depending on whether or not they preferred garlic or peanut oil in their food.

T. T. READ.

Washington, D. C.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial "The Chemistry of Olfactics" will say that rhodium oil is not by any means an uncommon substance. This is another name for oil of rosewood from *Convolvulus scoparius* and *Convolvulus floridus*, coming from the Canary Islands.

Syracuse, N. Y. WILLIAM BOOTH.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—The editorial section of this journal is usually so accurate and its policy in general so correct that a little malicious satisfaction at the slip made in the issue of the 23d inst. in the discussion of the odor of rhodium as being attractive to certain animals may be pardoned.

The rhodium referred to by the British correspondent is not the metal of the platinum group, but an oil distilled from a *Convolvulus* growing in the Canary Islands, and is used as an adulterant of oil of roses. It has also been used very extensively by trappers and hunters to attract animals to their traps, and was so used for many long years before the discovery of the metal rhodium.

It is a pity to thus "muss up" the elegant scheme of the ex-president of the Electrochemical Society relating to a rat detective corps for platinum thefts.

Washington, D. C. WELLINGTON B. JOHNSON.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Long before I had ever heard of rhodium, the element, in my days as an apprentice-apothecary, I was well acquainted with the rhodium of the catcher of rats, mice, muskrats and such vermin and rodents generally. The title in full is oil of rhodium. In some early text-books it is Latinized as *Oleum ligni rhodii*. I believe that it is derived from *Genista canariensis* or some allied plant. Its use is most largely in the adulteration of oil of rose. In truth, the rodent-bait is not real oil of rhodium but copaiba scented with oil of rose or with oil of rhodium.

Ain't it true as how to the chemist all is chemical; to the botanist all is botany—to the editor (I admit the epithet) all is—what-in-ell is it anyhow? Yours for a broader life (Volstead volens). HUGH CRAIG.

Oil, Paint and Drug Reporter,
New York City.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—I presume that by this time the interesting hypothesis that the olfactory sense of rats might be utilized as a reagent for the platinum group of metals has been given up, and that you have ascertained that

what the London writer wrote was, in fact, rhodium; or more explicitly, oil of rhodium, or rosewood (*Convolvulus* species); habitat, Canary Islands and elsewhere; odor, resembling roses and sandalwood, etc.

Not a very bad error for a metallurgical chemist; certainly more excusable than the reply of the wise lexicographer of a well known New York weekly who gave the meaning of the word "bitulithic" as "a chemical term, meaning two equivalents of the element thulium"! F. D. DODGE.

Brooklyn, N. Y.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent editorial of your journal on the phenomena of odors you have apparently confused the metal rhodium with the herb by that name. See for example Lippincott's "Medical Dictionary"; under "Rhodium" there appears the definition as follows: "The root wood of *Convolvulus scoparius*, the oil of which has the odor of rosewood." CARLETON ELLIS.

Montclair, N. J.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—I would like to correct an error in the editorial on "The Chemistry of Olfactics," which appeared in your issue of March 23, 1921. The writer of the editorial evidently takes "rhodium" to mean the element rhodium when he wonders why the rats are so keen on it. He even wonders what the London writer wrote that the printer mistook for rhodium.

Being conversant with the noble art of pharmacy, may I not point out that the joke is entirely on the writer of your editorial and in justice to his colleague of the London *Daily Mail* the mistake should be corrected.

Rhodium is the root of *Convolvulus scoparius*, growing in the Canary Islands. The oil obtained from this source is the article which was used as a lure for rats before the advent of the Pied Piper and Rough on Rats.

Columbia University, New York City. WILLIAM J. HUSA.

Dust Explosions

To the Editor of Chemical and Metallurgical Engineering

SIR:—We read with a great deal of interest the article on "Dust Explosions," by D. J. Price, in the March 16 issue of CHEMICAL AND METALLURGICAL ENGINEERING. On page 474, under the heading of dust removal, we note the following interesting paragraph:

> In installations of this nature, a flammable mixture is usually formed when the dust passes through the exhaust fan. Explosions may be caused by the ignition of the dust by sparks from foreign material striking the fan blade or from the fan blade becoming loose. This situation has suggested the possibility of changing the location of the fan from its present position—namely, between the source of dust production and collection—to a position beyond the cellector. In other words, can the dust be drawn into rather than blown into the collector?

We wish to draw the attention of the author of this article, and of engineers in general, to the fact that we have foreseen this danger and have eliminated all such fire and explosion hazards by placing the fan between the adjustable air separator and the centrifugal collector in our systems of dust collection. In all of our installations we have succeeded in removing the dust from the air, either partly or completely, before it is passed through the exhaust fan. The practical result is that in none of our installations has there been any fire or explosions. CLARK DUST COLLECTING CO.

Chicago, Ill.

Cost of Nitrogen Fixation in Norway

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of March 23 you published an article by T. C. Hagemann on "Cost of Fixed Nitrogen in Norway." Under the heading "Steps in the Process" Mr. Hagemann states that: "The air to be treated is let into a chamber, where it passes through an electrical arc, which by some artificial means is given an increased area in order to heat the air so intensely that a part of the nitrogen burns—that is, combines with the oxygen and forms NO."

I have been fortunate enough to have seen the large plants at Rjnkan, Norway, and have also made myself acquainted with the theory upon which the Birkeland-Eyde furnace is designed. To my knowledge of the question at hand Mr. Hagemann makes an error in stating that the arc "is given an increased area in order to *heat* the air so intensely," etc. Also Mr. Hagemann should have mentioned of what nature the artificial means were that gave the increased area to the arc. To me these two things appear to be of the utmost importance because they are the main features in making the Birkeland-Eyde process commercially successful; hence they should be correctly stated.

In the chamber water-cooled copper electrodes are employed, the arc being "started" by bringing one of the electrodes close to the other by means of a screw device. As soon as the spark "jumps" the gap the electrode is screwed away to increase the length of the arc. It is clearly seen that the efficiency would be very low if the air which is blown through the furnace could come in contact with only the comparatively narrow arc, hence Prof. Birkeland and Mr. Eyde, utilizing the well-known fact that a magnet will deflect the arc, placed a powerful magnet on one side of the arc and a similar magnet diametrically opposite. With one magnet functioning, the arc will be "pulled out" to a semi-disk. The two magnets are alternately charged and discharged with a very high frequency, thus making the two semi-disks appear to be a complete disk. This is of course not done in order to "so intensely *heat* the air" but in order to increase the area in which the air comes in contact with the intense heat of the arc.

To summarize, the artificial means are simply two electromagnets and the increased area is given in order to give a larger heating surface—*not* increased heat. Steps in a process of such merits as the Birkeland-Eyde process should not for a moment be allowed to become wrongly stated. K. W. JENSEN.

Detroit, Mich.

The Border Lines of Colloid Chemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 547 of CHEMICAL & METALLURGICAL ENGINEERING, March 30, 1921, there appears the following statement:

> On the basis of our present chemical status, the colloid chemist may pass off the contribution by Dr. Loeb in this issue with the statement that his observations have been limited to dilute solutions and that Dr. Loeb has only confirmed a common belief that any properly dispersed substance in a proper degree of subdivision will obey the gas laws and the others derived from them.

May I be pardoned for pointing out that the solutions and the gels of proteins used in my experiments were no more dilute than those on which the colloid chemists have based their hypotheses? JACQUES LOEB.

New York City.

The New President of "Tech"

DR. ERNEST FOX NICHOLS, physicist, the new president of the Massachusetts Institute of Technology, was born in Leavenworth, Kan., fifty-two years ago. He obtained his Bachelor's degree in science at the Kansas Agricultural College in 1888. Then he went to Cornell, where he was a graduate student in science from 1889 to 1892, and there he took his Master's degree. From 1892 to 1896 he was professor of physics at Colgate University, but in part time, from 1894 to 1896, he was at the University of Berlin with Prof. Rubens, where, in their joint work, they were pioneers in the modern study of infra-red rays. For a long time the infra-red rays measured by them were the longest that had been recorded. In 1897 he took the degree of Sc.D. at Cornell. During another interim, 1894-95, he studied at Cambridge University, England, and in 1898 he became professor of physics at Dartmouth. While there he undertook the problem of measuring the pressure of light, which had been open since the days of Maxwell. In this, working in conjunction with G. F. Hull, the outcome was successful, and they succeeded in proving and measuring with considerable accuracy the forward pressure which a beam of light exerts. Lebedew in Russia was engaged in similar studies and published his findings a month or so earlier, but his results were less exact, and rather of a qualitative nature as compared with those of Nichols and Hull, which were more definitely quantitative.

DR. ERNEST FOX NICHOLS

From 1903 to 1909 he was professor of experimental physics at Columbia University, New York. This was, in effect, a research professorship, and here he soon had a group of students making investigations in the infra-red spectrum, and working on the generation, reflection and diffraction of short electric waves. At the same time, on his own behalf, he engaged in the effort to check up experimentally some of the fundamental assumptions of the electromagnetic theory, and particularly that of moving charges of electricity.

In 1909 he was called to the presidency of Dartmouth, where he remained for seven years, and in 1916 he became professor of physics at Yale. During his professorship at Columbia he was research associate of the Carnegie Institution at Washington in 1907-09, and from 1917 to 1919 he was in the Bureau of Ordnance of the U. S. Army, so that the war gave him but little opportunity for work at New Haven. Last year he left Yale to take up research in pure science with greater facilities and a larger staff than any university can offer, at the General Electric Co.'s laboratories at Nela Park, Cleveland. He has seven honorary doctorates and many medals and other distinctions.

More important than the details of his history is the manner of man that he is. He enjoyed the process of education in three countries: the United States, Germany, and England. His preference is for the English type of culture over that of Germany. His theory of an engineer is that he must first of all be an educated gentleman rather than a man with the recollection of many facts loaded upon a possibly insecure foundation of understanding. All thoughtful friends of Tech have recognized that the school might develop into an institution for highly specialized training on the one hand, or an institution of advanced and progressive scientific scholarship on the other. The selection of Prof. Nichols indicates that the trustees had in their choice the latter ideal in mind.

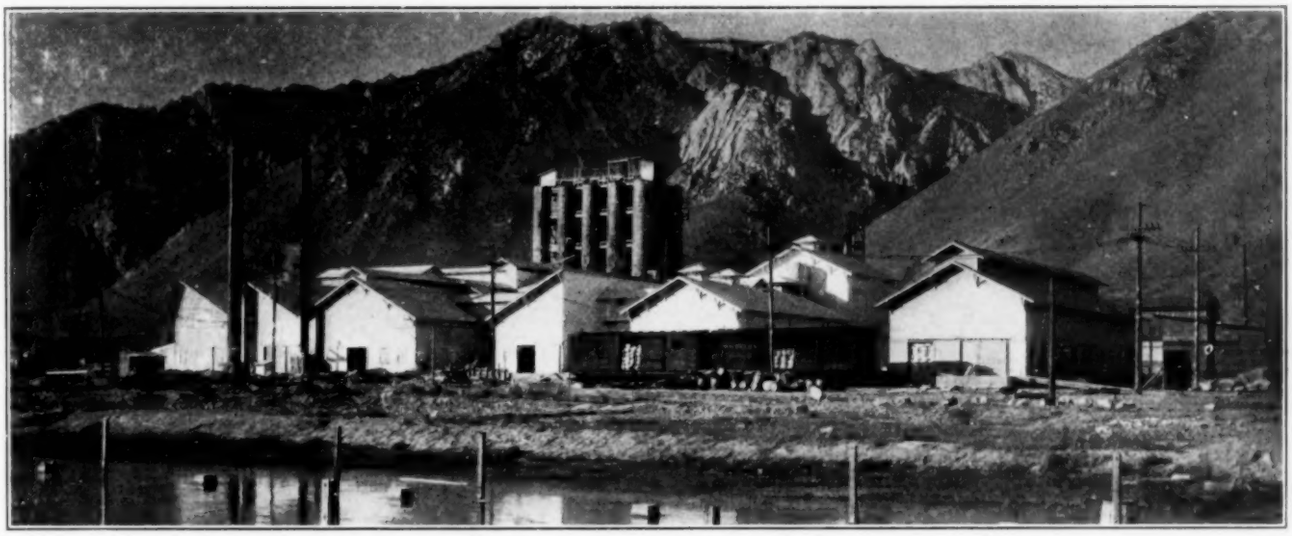
His change from research and teaching to administration and back again is in accord with his order of life. His interest in the general problem of education has always been acute, and at the same time he is an experimental physicist of the first rank. While president of Dartmouth he continued to teach. Before he accepted the post he told his friends that he would stay there for seven years, and at the end of seven years he did return to teaching and research. He thinks a long way ahead, and with precision.

He is reserved in manner, a man of dignity and yet excellent company, who does not carry his heart in his sleeve. He is kindly and helpful to earnest and competent students, an inspiration to those who are gifted with rare understanding and character, but has very little patience with those who do not take their work earnestly or seriously.

His scientific curiosity is keen and persistent, but its tendency is rather toward fundamental problems than toward the filling in of unimportant gaps. While his habit of mind is large, it leans to the experimental rather than to the purely theoretical side. He has slight interest in the co-ordination of guesses, but immense interest in the co-ordination of facts. And he is richly gifted with common sense.

The late president, Dr. MacLaurin, had completed the first part of his work. His next task, at the time of his passing, was to be the internal development of Tech and the consolidation of its great resources of scholarship.

It is a big job. But we believe the trustees have exercised unusual wisdom in seeking and finding the right pilot.



CALIFORNIA ALKALI CO. PLANT

Salts-Refining Plants at Owens and Searles Lakes

Report of a Recent Survey of the Salts-Refining Plants Producing Natural Soda Ash, Borates and Potash in the Owens and Searles Lakes District of California

By L. W. CHAPMAN

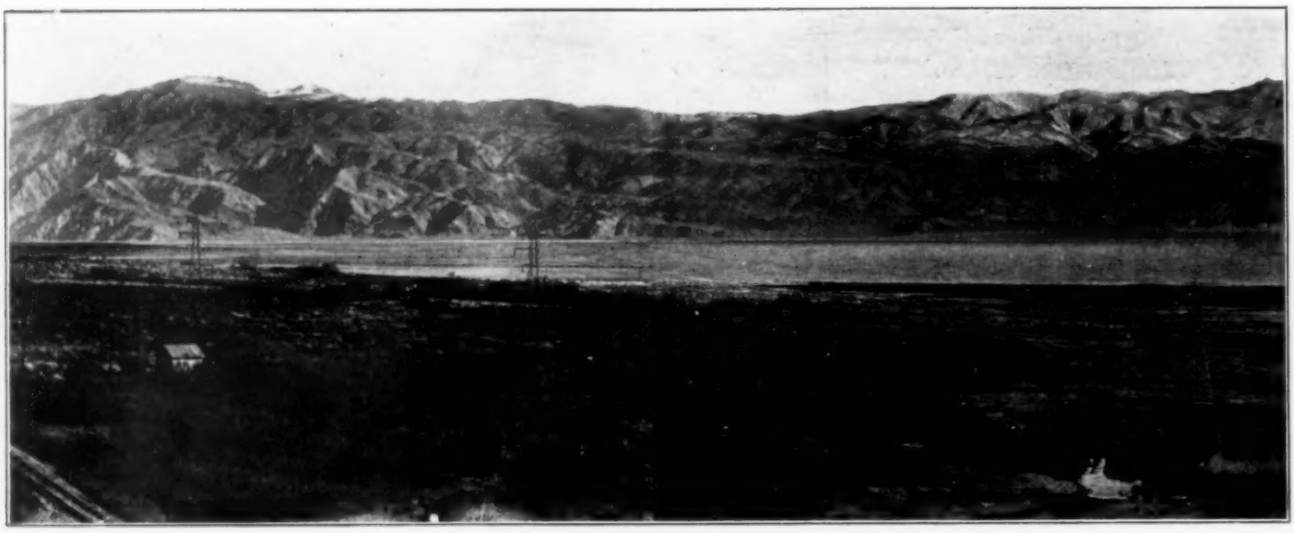
OWENS LAKE, in Inyo Co., Cal., is the principal source of natural soda in the United States. Searles Lake, in San Bernardino Co., Cal., was the second largest producer of potash from a single domestic source in 1919 and probably retained that position in 1920; in addition, an appreciable quantity of borax is being recovered at the Searles Lake plants as a byproduct. At Owens Lake there are three operating companies and at Searles Lake there are four; with a single exception the plants have become producers during the last six years, and two of the plants will market the first of their product in 1921. These developments indicate an appreciation of the importance of the sources of raw material as well as an increase in the demand for the refined products. The amount of recoverable soda, potash and borax is not unlimited, but is sufficient to meet local demands for many years, and with economical methods of operation should play a prominent part in the industrial development not only of the West, but of the country as a whole. These notes describe briefly the geology of the district and the different processes now in use for obtaining commercial products.

Geological Considerations

Owens Lake, Searles Lake and Panamint Valley are to be considered together geologically, there being evidence that in Quaternary times they constituted a chain of lakes, the water, at that time probably quite fresh, flowing through the series in the order named. The drainage area of this lake system covers about 9,600 sq.mi. (24,900 sq.km.), and there are no indications that there ever was an outlet to the ocean. Owens Valley has an area of 2,800 sq.mi. (7,250 sq.km.), and is located between the Sierra Nevada Mountains on the west and the Inyo Range, a southern continuation of the White Mountains, on the east. The drainage area of Searles Basin is about 4,850 and of Panamint Valley about 1,950 sq.mi. (12,600 and 5,050 sq.km. respectively). Owens Lake is the only existing remnant of the lake system; the others are completely dry, except occasionally during the rainy season when a few inches of water may cover a portion of the crystal surface of Searles Lake for a few days.

Owens Lake changes considerably in area from year to year, depending upon the ratio of the evaporation to the inflow of water; the present level of the surface above sea level is 3,565.58 ft. (1,086.79 m.); it is approximately 13 mi. long by 8 mi. wide at the present time (21 by 13 km.). The rate of evaporation of Owens Lake brine is about 40 in. (1 m.) per year. During the last three years the water level has lowered quite rapidly; 40.5 in. (103 cm.) in 1918, 48 in. (122 cm.) in 1919 and 51 in. (155 cm.) in 1920, and this has had the effect of concentrating the salts in the brine. But little further evaporation is needed to make it possible to use the lake brine without solar concentration in the soda ash works.

The present area of the lake is about 42,000 acres (17,000 hectares) and the volume approximately 381,000 acre-feet (470×10^6 cu.m.). Dr. W. Hirschkind, of the California Alkali Co., estimates the quantity of salts in the brine to be, in million metric tons: Na_2CO_3, 46.6; $NaHCO_3$, 11.08; Na_2SO_4, 19.4; NaCl, 51.5; KCl,



OWENS LAKE, INYO COUNTY, CALIFORNIA

5.53; $Na_2B_4O_7$, 3.55. In the table are given analyses of the lake water, showing the effect of the level of the water in the lake upon the concentration of the salts. But a slight increase in concentration will cause crystallization of trona, $Na_2CO_3.NaHCO_3.2H_2O$, during the summer months.

The relative position and elevation of Owens and Searles Lakes are shown in Fig. 1 and the Quaternary lakes are indicated. It seems probable that during the geological history there was more than one desiccation

TABLE I. ANALYSES OF OWENS LAKE WATER

	Sept., 1886*	June, 1918†	June, 1920†
Sp. Gr.	1.062 at 25 Deg. C.	1.108 at 15.5 Deg. C.	1.222 at 15.5 Deg. C.
Total salts	7.26	10.45	25.53
H_2O	92.74	89.55	74.47
Na_2CO_3	2.54	3.55	8.32
$NaHCO_3$	0.54	1.00	1.85
Na_2SO_4	1.05	1.47	3.77
NaCl	2.78	3.78	9.87
$Na_2B_4O_7$	0.05	0.24	0.64
KCl	0.30	0.41	1.08

* Calculated from an analysis by Chatard, U. S. G. S. Bull. 60.
† Analysis by Natural Soda Products Co., Keeler, Cal. In October, 1920, the brine had a gravity of 1.23, with 28.4 per cent total salts.

and probably more than one period during which the waters flowed from Owens Valley through Indian Wells Valley and Salt Wells Valley into Searles Lake. Whether this had an appreciable effect on the relative composition of the brine remaining in Owens Lake and the crystalline deposit with its retained mother liquor at Searles Lake has not been determined, although Gale[1] is of the opinion "that these [Searles Lake] deposits are the normal product of the desiccation of a body of water of the same chemical character as the Owens Lake of the present time." It also seems probable that there was no considerable overflow from Searles Basin into Panamint Valley in what is to be considered recent geological history, and that therefore the greater portion of the deposited salts is the accumulation from the drainage system which includes both Searles and Owens Lakes, since this overflow. The water in Owens River comes principally from the Sierra Nevada Mountains, and at its present volume is adding more than 15,000 tons of sodium annually to Owens Lake. It is probable that part of the accumulation of salts in Searles Lake was derived from Owens Valley as well as from the much larger Searles Basin.

The dry lake basin that is known as Searles Lake is superficially much like other playa deposits of the Great Basin region.[2] One very evident indication that the basin was occupied by a deep lake is the old shore line which is distinct at an elevation of about 635 ft. (193.5 m.) above the present surface. The basin is roughly circular, 15 to 20 mi. in diameter (24 to 32 km.). Near the center of the basin is an area about 12 sq.mi. (35 sq.km.) in extent, the surface of which is

[1] Bulletin 580-L, U. S. G. S., by Hoyt S. Gale.

[2] See G. J. Young, "Potash Salts and Other Salines in the Great Basin Region," Bull. 61, U. S. Dept. of Agriculture, for a geochemical description.

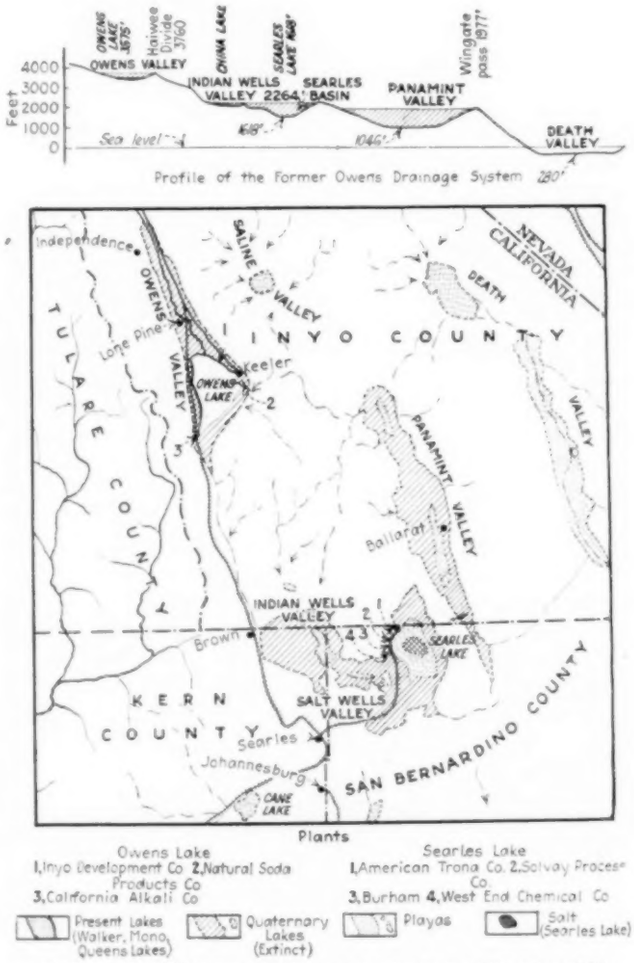


FIG. 1. OWENS-SEARLES-PANAMINT LAKE SYSTEM

OWENS LAKE, INYO COUNTY, CALIFORNIA

composed of quite pure sodium chloride. Beneath this is the "crystal body," a coarsely crystalline deposit containing a large variety of minerals consisting chiefly of halite, thernardite, trona and borax. Gale[3] reports sixteen, stating that the list is incomplete. Clark[4] lists twenty-two; to these must be added glaserite,[5] $3K_2SO_4$. Na_2SO_4, and possibly some others. The crystalline deposit is from 65 to 75 ft. (19.8 to 22.8 m.) in depth and is saturated to within a few inches of the surface with a brine of the composition shown in Table II.

The brine is variously estimated to occupy from 25 to 40 per cent of the volume of the crystal body. It averages 4.2 per cent potassium chloride and 1.1 per cent anhydrous sodium tetraborate. Using the lower estimate for the amount of brine in the crystal body, the KCl content is over eight million tons, and the borax content over four million tons. This estimate does not include any salts that may be added to the brine through solution from the "crystal body," so that the amount of recoverable salts may be much greater.

The central salt deposit is surrounded by a margin of mud, clay and sand, incrusted with salts or impregnated with solution. The Argus Range on the west and north separates the Searles Lake Basin from Coso Valley, this being separated from Owens Valley by the Coso Range. The abrupt wall of the Slate Range divides the basin from Panamint Valley to the east.

Operations at Owens Lake: Inyo Development Co.

Of the three plants at Owens Lake that of the Inyo Development Co. on the east shore of the lake was the first to be operated, soda ash having been produced at this plant since 1886. The plant is designed to produce a crude dense soda ash by melting trona, obtained by solar evaporation of the lake brine. The plant is now operated by the California Alkali Co. Brine from the lake is pumped into the series of solar evaporating ponds in the spring after the previous year's crop of trona has been harvested. The brine as it becomes concentrated in the first pond, due to evaporation, is run into the second pond of the series and the first pond is filled with water from the lake. This process is continued until a sufficient amount of sodium carbonate is contained in the ponds to give the required amount of trona in the season's crop. The concentrated solution finally is run into crystallizing ponds, and trona is precipitated. Toward the end of the season, usually in October, the nights become cool and if the solution remains in the ponds the cooling of the liquor will crystallize out a mixture of sodium carbonate and sodium sulphate as decahydrate. The concentration of the liquor and the temperature are watched and when there are indications that there is a possibility that the trona may be contaminated by the salt and sulphate the remaining liquor is run into the lake. As soon as the deposited salts are drained harvesting is begun. The trona forms a hard crust on the bottom of the ponds, which is broken up with picks and loaded into side-dump mine cars, which are hauled to the plant on a narrow-gage track by a gasoline locomotive. The trona is dumped into a bin, where it is washed with water, loaded into dump cars and hauled to a storage pile to dry.

The dried product is melted in the furnace shown in Fig. 2, crude oil being used for fuel. The molten carbonate runs in a thin stream into a blast of air which produces a globular product analyzing from 55 to 56 per cent Na_2O, less than 2.5 per cent Na_2SO_4 and a small amount of NaCl. From 18,000 to 24,000 tons of trona is produced per year, which is in part converted into soda ash and in part marketed as such.

Natural Soda Products Co.

On the east side of Owens Lake, about three miles south of the plant of the Inyo Development Co., is the plant of the Natural Soda Products Co. This was built

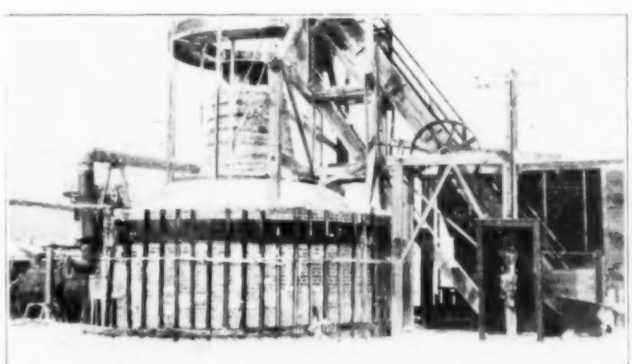


FIG. 2. FURNACE FOR MELTING TRONA, INYO DEVELOPMENT CO.

[3] Gale, Bull. 580, U. S. G. S., p. 265.
[4] F. W. Clark, "The Date of Geochemistry," Bull. 695, U. S. G. S.
[5] W. F. Foshag, *Am. J. Sci.*, vol. 49, May, 1920.

in 1915 and reconstructed after a fire in 1917. Melted soda ash has been the principal product, although crude trona and crude sodium bicarbonate have also been sold in small quantities. New equipment is being installed to produce a high-grade light soda ash. After evaporating the lake brine in a system of solar ponds to the degree of concentration where trona will crystallize upon further evaporation, the concentrated liquor is pumped to carbonating towers. Carbon dioxide gas, obtained from kilns, is forced through the towers, precipitating sodium bicarbonate. The crystals are separated by filtration, air-dried in a storage pile (Fig. 3) and melted in an oil-fired furnace. The molten sodium carbonate is atomized by an air blast and the product is ground, screened and sacked for the market. Plant capacity is about 140 tons of this product per day. The new equipment will produce fifty tons of light ash, and a portion of the light ash can be converted into dense ash.

Limestone, in the form of a high-grade dolomitic marble, is obtained from a quarry about 9 mi. north of the plant. Coke is shipped from Utah. Rail transportation is provided by a narrow-gage line of the Southern Pacific which runs north to Mina, Nev., from the town of Keeler, on the east shore of the lake. Connection is made at Owenyo with the standard-gage line of the Southern Pacific running south to Mojave, Cal.

California Alkali Co.

At Catago, near the southwestern end of the lake on the standard-gage line previously mentioned, is the plant of the California Alkali Co. The method of operation is practically the same as at the Natural Soda Products Co., but no melted ash is produced and details of operation and equipment are somewhat different. Brine is pumped from the lake and concentrated by solar evaporation, and the concentrated liquor is filtered before carbonating. The bicarbonate is converted into light ash in standard light ash furnaces, the product being of a very high grade. Dense ash furnaces are now being installed and a portion of the light ash now being produced will be made into dense ash. Total production will be about eighty tons a day.

FIG. 3. 10,000 TONS OF NATURAL SODIUM BICARBONATE, AT NATURAL SODA PRODUCTS CO.

As is evident from the brief description of the Owens Lake operations, the method of making soda ash is similar to the Solvay process, with the exception that no ammonia is used. Carbonating towers, furnaces and other equipment are of the standard design used in the alkali industry, except the furnaces for melting the crude trona at the Inyo Development Co.'s plant and for making the melted ash at the Natural Soda Products Co.'s plant, which are of special design.

Brine from Owens Lake is particularly suited for the manufacture of soda ash. The mother liquor from the carbonating tower contains both borax and potassium, the latter in the form of chloride. The liquor is not utilized at present, but it would seem possible to work out a method for profitably recovering these salts as byproducts of the soda ash operations. An experimental plant is being built by Wrinkle & Kuhnert for the production of borax and potash near the plant of the Natural Soda Products Co., and in the experimental runs will use the mother liquor from the carbonating towers after further solar concentration. The estimated capacity of the plant is ten tons each of potash and borax and twenty tons of sodium bicarbonate per day.

After the carbonates have been precipitated from the raw lake brine by solar evaporation, it is possible to crystallize from the residual liquor a crude sodium sulphate with which is mixed common salt. This material has a possible commercial value. It does not seem probable that salt can be produced at Owens Lake at a cost low enough to compete with that which is now being recovered from salt deposits in Inyo and San Bernardino counties, or with that obtained from sea water at plants near San Diego and San Francisco.

Searles Lake Operations

Searles Lake was discovered by Dennis Searles and E. M. Skillings on Feb. 14, 1873, and 160 acres (64.75 hectares) of borax claims were located and patented by them.[6] Borax was first produced in 1874 and the deposit continued to be an important source of raw material until the discovery of the colemanite deposits in Death Valley and other localities in California. It would seem that C. E. Dolbear was the first to recognize the importance of Searles Lake as a source of potash, but the possibility of recovering potassium chloride was pointed out at about the same time by the U. S. Geological Survey. The first company to produce potash from the brine was the American Trona Corporation, which began active operations in 1915, first building a railroad 30 mi. in length fron the line of the Southern Pacific to the lake. The company now has an investment in railroad, plant and equipment, housing facilities for the staff and workmen, water supply, etc., of over $6,000,000.

American Trona Corporation

In outline the process of the American Trona Corporation is not complicated. Brine is obtained from wells drilled in the salt body, 500,000 gal. (1,900 cu.m.) being pumped per day to storage tanks at the plant.

[6] Henry G. Hanks, in his Third Annual Report of the California State Mineralogist, gives original information on the discovery and geology of Searles Lake.

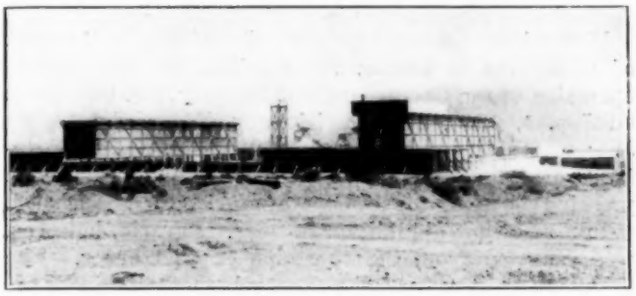


FIG. 4. SPRAY TOWERS OF THE WEST END CHEMICAL CO. AT SEARLES LAKE

Fresh brine, mother liquor and wash water are fed to triple effect 22-ft. (6.7-m.) Manistee evaporators and a hot solution concentrated with respect to KCl is obtained. This is cooled rapidly, first with raw brine and then by refrigeration, and a crop of KCl crystals produced. The crystals are separated from the mother liquor in centrifugals. Borax is recovered from the residual liquor and purified by recrystallization. Boiler equipment consists of twelve 500-hp. Babcock & Wilcox boilers, about 4,000 hp. being used. Evaporators contain 40,000 sq.ft. (3,716 sq.m.) of heating surface per unit. Three 200-ton refrigerating machines are installed and about 400 tons per day is required for cooling solutions and other uses about the plant.

TABLE II. ANALYSIS OF SEARLES LAKE BRINE AND PRODUCTS OF AMERICAN TRONA CORP.

	Per Cent by Weight		
	Raw Brine	Refined KCl	Refined* Borax
NaCl	16.54	1.85	None
KCl	4.82	92.84	0.33
Na_2CO_3	4.82	0.69	None
$Na_2B_4O_7$	1.50	0.45	51.72
Na_2SO_4	7.16	0.19	0.01
H_2O	65.16	3.98	47.94
Total	100.00	100.00	100.00

* $Na_2B_4O_7 \cdot 10H_2O$, dry basis 99.65 per cent; free moisture 1.91 per cent.

An analysis of the refined products and of the raw brine is given in Table II. It will be noted that the potassium chloride is comparatively free from borax. To obtain a product of this degree of purity has been one of the most difficult problems at the plant. A further operating difficulty has been the frothing of the evaporators, but this has been recently overcome. Improved operating methods, that will be made possible when the installation of new equipment is completed, will increase production and further improve the quality of the potassium chloride. About fifty tons of potash and twenty-five tons of refined borax is being produced per day. It is to be noted that the process depends entirely upon the use of artificial evaporation to obtain a concentrated brine.

Solvay Process Co.

The borax claims of Searles and Skillings are controlled by the Pacific Coast Borax Co. This company and the Solvay Process Co. built a plant in 1916 and 1917 for the recovery of borax and potash from brine obtained from the salt body. The plant is now managed by the Solvay Process Co., and no authorized statements have been given out concerning the method of operation or the amount of production. The following outline of the process is believed to be correct: Preliminary solar evaporation of the brine is depended upon to give a solution of maximum concentration without the crystallization of potash salts in the ponds. Further evaporation in multiple effect evaporators produces a hot concentrated potash solution from which a crop of KCl crystals is obtained. These are separated by filtration and the mother liquor is treated either with CO_2 gas directly or with SO_2 gas which breaks up the carbonates, giving CO_2 and sodium sulphite. The treatment converts the biborate into the less soluble metaborate, and borax crystals are obtained from the solution upon cooling. As contrasted with the process at Trona a less amount of fuel is required.

West End Chemical Co.

The third plant to be established at Searles Lake is that of the West End Chemical Co., and the plant will become an active producer this year. The process uses less fuel than the two described, no use being made of artificial evaporation for producing a concentrated liquor. Brine is pumped from the crystal body to preliminary ponds, thence to secondary ponds for final concentration. When a solution of maximum KCl content is obtained it is pumped to a storage tank at the plant. Spray towers, shown in Fig. 4, are used to produce a crop of mixed crystals containing borax and potash. Spray towers are made of wooden frames covered with corrugated iron, and the solution is sprayed downward through 1-in. nozzles by pumps having a capacity of 12,000 gal. (45,000 liters) per minute. Recirculation of the liquor which drains from the deposited crystals recovers a large portion of the potash salts. About six tons of salts is produced per hour in the spray towers. The deposited salts are filtered, and dissolved in hot water, producing a hot concentrated KCl solution, from which crystals are obtained upon cooling. Borax is recovered from the mother liquor.

An optional method, which permits of winter operation, is as follows: A deposit of mixed salts is obtained during the summer months by solar evaporation in ponds about 3 ft. deep. These are harvested in the fall and winter, crushed and leached with hot water, KCl and borax being recovered as described.

Burnham Process

All three of the plants at Searles Lake so far described use fuel oil for heating solutions or for evaporation and have a more or less expensive plant and equipment. The cost of fuel oil and interest on investment are important items in the cost of producing the marketable product. A fourth process is operated at Searles Lake, the distinctive feature being the use of solar evaporation only for the production of borax and potash. The process is the invention of G. P. Burnham.[7] Advantage is taken of fractional crystallization at different concentrations and temperatures, and the brine is so manipulated that the various salts come down separately in different ponds. The rate of evaporation from brine at Searles Lake is about 6 ft. (1.83 m.) per year. The brine contains eighty tons of KCl and fifty tons of borax per acre-foot (5.0 and 3.7 kg. per cu.m. respectively), so that a 100-acre (40.5-hectare) pond evaporating continuously will deposit 48,000 tons of potash and 30,000 tons of borax per annum. (A 10-hectare pond evaporating continuously will deposit 1,080 metric tons of KCl and 677 metric tons of borax per annum.)

In the Burnham process several ponds are provided and the potash is made by flowing the brine into shallow ponds during the summer days, then into deep ponds

[7] U. S. Pats. 1,328,614, 1,286,932, 1,317,954, 1,321,282.

FIG. 5. HARVESTING PURE SALT FROM THE SURFACE OF "CRYSTAL BODY" AT SEARLES LAKE

at night, in order to retain the heat. By continuing the process warm evaporation is maintained until the brine becomes concentrated with KCl. At this point the brine is circulated between two shallow ponds, and cooling at night crystallizes out KCl in one pond and during the day further warm evaporation crystallizes out NaCl in the other.

Borax is made by flowing the brine into shallow ponds at night during the winter to cool, sodium sulphate and sodium carbonate being deposited. When the brine is coolest, in the early morning, it is flowed into deep ponds where the temperature is maintained for several days, borax gradually crystallizing out.

It was previously mentioned that the surface of the crystal body at Searles Lake was composed of quite pure sodium chloride. Salt is harvested by the American Trona Corporation, a special market existing for the product, which is entirely free from calcium and magnesium compounds. A spiked-tooth harrow is used to loosen the hard crust to a depth of about 2 in. and the salt is scraped into windrows by a road scraper. It is then shoveled into side-dump mine cars, a train of these being hauled alongside the rows from a narrow-gage railroad by a tractor. The loaded train is returned onto the track by the tractor and hauled to the plant by a gasoline locomotive. The salt is dumped into storage piles and after air-drying is loaded into standard-gage box cars for shipment.

In addition to potassium chloride, borax and salt, it would seem that sodium sulphate and carbonate could be obtained from Searles Lake brine, at least in crude form, and a market developed for the product for such uses as the manufacture of glass and paper pulp. It is a safe prediction that processes will be developed for the commercial production of all the salts contained in the brine of both Owens and Searles Lakes.

To establish a chemical industry in the heart of a desert is not a simple undertaking; housing, a complete commissary and other accommodations have to be provided for the workmen and living conditions made as comfortable as possible. An especially large stock of general supplies has to be carried on hand at all times, machine shop and other repair facilities have to be of the best. That successful operations are now conducted in these out-of-the-way places is to the credit of the men who have pioneered in the establishment of a new industry.

The writer wishes to acknowledge the courtesies extended by the management of the plants at Owens and Searles Lakes in gathering information for the preparation of this article.

The German Cement Industry

Howard W. Adams, representative of the Department of Commerce in Berlin, reports that the government operation of the German cement industry, put into effect on Jan. 1, 1917, was provisionally dispensed with on July 27, 1920, by an order issued by the Federal Ministry of Labor. This action was taken because the pressing demand for cement appeared to be satisfied, with a resultant diminution in sales. Bavaria, however, was excepted from the operation of this order. The government, through the Federal Commissioner for Cement, still retains jurisdiction over the fixing of prices for the domestic market.

Course of Cement Prices, 1914-1920

The price of cement in Germany at the outbreak of the war was 350 marks per 10,000 kilos (kilo = 2.2 lb.) for both government and private contracts. Following the establishment of government operation of the cement industry and the accompanying official regulation of prices there was a rapid rise in the cost of this commodity. The following prices per 10,000 kilos (f.o.b. mill and exclusive of packing) show the course of these prices since 1914:

Periods	On Government Contracts Marks	On Private Contracts Marks
August 1, 1914	350	350
January 1, 1917	430	430
October 1, 1918	735	760
April 1, 1919	885	910
April 1, 1920	3,991	4,061
August 1, 1920	3,330	3,400

Increase in Production

During the middle of last summer the production of cement was somewhat increased, due in part to the resumption of operations by the Offenbacher Portland-Zementfabrik (Gruppe der Portland-Zementwerke Heidelberg-Mannheim-Stuttgart) after lying idle for more than five years. The cement industry in Germany has not felt the effect of the coal shortage as much as other lines of manufacture for the reason that the mills were, to a considerable extent, able to use low-grade coal. Germany has resumed the shipment of cement to foreign markets.

Recent Prices for Cement

An idea of the recent domestic prices of German cement may be gained from the order issued Dec. 8, 1920, by the Federal Commissioner for Cement, with retroactive effect from Nov. 1, 1920, and extending to and including Jan. 31, 1921. According to this order the following prices are fixed for this period: For the district of the North German Cement Manufacturers' Association, 3,200 marks per 10,000 kilos (f.o.b. mill and exclusive of packing); the Rhine Westphalian Cement Manufacturers' Association, 3,100 marks; and for that of the South German Cement Manufacturers' Association, 3,300 marks. Proportionally lower prices are fixed for contracts for cement to be furnished the state governments for use in public buildings. The three sets of prices indicated above represent a considerable reduction over the prices fixed for the three months preceding Nov. 1, such reduction being to the extent of 200 marks, 300 marks and 100 marks, respectively. In this order of the government protection was provided the manufacturers against increases in the cost of coal during the Nov. 1-Jan. 31 period by allowing for an increase of 55 per cent.

Promotion of Scientific Research

Outline of a Program for Forwarding Research in the Chemical and Physical Sciences at the Universities —Industries Licensed Under Patentable Discoveries to Pay Reasonable Royalties for Support of Further Research—An Impartial Study of Facts

By WILLIAM HOSKINS* and RUSSELL WILES†

THIS plan is derived from the suggestions of several different people who have given attention to the subject, and an especial object has been to reconcile various conflicting views so as to conserve the interests of the public and of the universities to the fullest extent.

Need of University Research

Initially, let us consider the ultimate object to be accomplished. It is probably not necessary to argue that an immense increase in scientific research is perhaps the most important future step for the welfare of this country. It is only by such research, commencing as pure science and ending as applied science, that production and therefore the physical well-being of the people can be materially increased without a corresponding increase in labor. Eminent members of university faculties have repeatedly called attention to the important need of a tremendous expansion of scientific research. Industry is taking care of the application of science, and will do so to a continuously greater extent as experience demonstrates the wisdom of industrial laboratories and as the universities turn out trained research men capable of solving the problem.

But if research in pure science is not correspondingly increased the stream will dry up at its source not only from lack of fundamental information but from lack of trained men. Industry cannot be expected to maintain pure science laboratories, as the maintenance of such a laboratory in an industrial organization is difficult if not impossible. It seems evident that the proper place for pure science research is in our universities, where the atmosphere is admirably adapted to lead the investigator to examine his facts without any commercial or industrial bias.

Expansion of University Equipment a Serious Financial Problem

However, the expanson of the physical faculties of physics and chemistry by the addition of the requisite number of research professors and the expansion of equipment for their use is a very serious problem. It has been estimated by eminent and experienced scientists that a man should remain in pure science research for ten years after receiving his doctor's degree in order to become a thoroughly trained, mature and competent worker. At the end of such a ten years' experience the industries will be entirely capable of taking care of these men and will need them in industrial laboratories where today it is almost impossible to obtain any competent help. During this ten-year period, however, a man must be paid a sufficient wage as a research professor to keep him from entering industry prematurely, which means, as matters stand today, he probably must draw an average salary of $5,000 a year. If the university is to produce any respectable number of men after a course like this, it is evident that the research department or division must become a very large and expensive institution, since to turn out ten men in chemistry and ten in physics per year after ten-year courses would require two hundred residents continually. This number could be doubled or trebled for a long time without saturating industry.

Industry Must Finance

It has frequently been said that since in the end the discoveries in pure science will redound to the benefits of industry, therefore industry ought to finance the necessary expansion of the universities. It is, however, exceedingly difficult to secure this result in the usual way for several reasons. What is really meant by industry financing research is that a few large stockholders of industrial corporations shall finance research. Most corporations are not legally permitted to make donations direct to educational institutions. Under present methods our corporations are heavily taxed and the large stockholders are again heavily taxed on their depleted dividends so that there is little left for the universities. Besides it is a fact that the great bulk of small stockholders of corporations who profit by scientific research are never reached at all. The prime advantage of the present plan is that it enables payment to be made directly by industrial corporations in a legal manner and in proportion to the benefits derived by the corporations from scientific research and it permits the payments to be charged to expense so that they are free from burdensome income taxes.

Research Will Lead to Discovery

In the normal course of pure science, research made wholly without reference to any commercial end will inevitably discover novel processes, novel machines and novel compositions of matter, many of which ultimately become of the highest industrial importance and most of which can be patented because, in the eye of the law, they are patentable inventions. These inventions, being made without reference to a particular commercial end, are usually of the most broad and sweeping character and they frequently underlie whole groups of industries.

The industries which use these inventions produced in the universities as part of their regular work should pay for them out of corporate funds. It is reasonable that a very considerable income can readily be obtained in this manner without begging for charity, but as a matter of right. Most of our large corporations are glad and willing to pay liberally for anything which benefits them, especially if the proceeds are to be reinvested in furthering similar work, the advantage of

*Consulting chemist, Mariner & Hoskins, Chicago, Ill.
†Patent attorney, Dryenforth, Lee, Chritton & Wiles, Chicago, Ill.

which may later be reaped by the corporation. This result can be brought about through the patent system, and every objection so far suggested to the patenting of inventions by members of university faculties can be overcome not only technically but in spirit and substance.

Patents Open to All

And it is of the utmost importance that these inventions should not be monopolized in one or a few hands, but should be freely offered to the public for all possible uses upon very reasonable terms. This can be done by letting it become known that such patents are not for sale, that no exclusive rights will be granted, but that anyone can have a shop right or license for his own purposes and his own plant upon the payment of a reasonable fee. This is precisely what has been done with the patents in the Cottrell process, which have been held by the Research Corporation. The process is used in a great number of industries for all sorts of purposes and industry is in nowise hampered by the patents, since everyone knows he may use them freely upon paying a reasonable price. As a result other inventors treat the Cottrell patent as if it were entirely non-existent except that they realize that a reasonable royalty must be added to the cost of operation. The point is, however, that no one attempts to avoid this patent or to get along without it, simply because it is held under these unusual conditions. We see, therefore, no reason why the public should be injured in the slightest degree by the grant of more patents held in a like manner. Indeed, from the standpoint of the public, it would probably be more advantageous to have inventions patented and the patents held open to general use upon payment of a reasonable royalty than to continue as at present.

Present Practice Encourages Pirates

Today the practice of scientists is to present purely scientific papers dealing with laws rather than their application, and little or no mention is made of possible practical applications, even though these are more or less obvious. Almost immediately these papers are read by commercial investigators and the most evident practical applications are promptly patented. Thus neither the public, nor the inventors, nor the universities benefit, but in too many cases a small group of sharp-witted engineers secure the patents. In some cases these patents are invalid because the application of new truths is too obvious, but in others they are perfectly valid because the exceedingly abstract nature of the original thesis makes any concrete application of its principles patentable invention.

Furthermore, the thesis is written in a form unfamiliar to the Patent Office and the courts, and oftentimes fails to receive its full evidentiary weight in controversies affecting a subsequent patent. The public would be very much better off, and justice would be much more closely approximated in patent suits if, contemporaneously with the publication of a thesis, its substance were expounded in a patent drawn in the language familiar to the Patent Bar and the Federal Bench.

Furthermore, the existence of such patents would greatly enlighten the Patent Office and prevent the grant of numerous ill-advised patents which by reason of doubts as to their validity constantly embarrass industry. After a wide experience in patent matters and particularly those relating to chemistry, the authors are satisfied that industry at large would be vastly better off if all discoveries were patented as fast as they are made providing only that a liberal policy was followed in licensing the use of these discoveries. There is at large a type of engineer commonly called a "patent pirate," who thrives by monopolizing the practical applications of the abstract discoveries of others. The patent pirate is a menace to industry and a parasite on the community. Nothing would so hamper his activities as to have the real discoverer take out broad patents in every case.

Public, Not Individuals, to Benefit

It seems to be agreed that to permit members of the science faculties of our universities to patent their discoveries for their own personal benefit is an entirely wrong policy for several reasons. It tends to restrict directions in which research may be conducted by placing a premium upon lucrative lines of investigation; and worse still it tends to focus the attention of the investigator upon applied science rather than pure science and *pro tanto* causes the university laboratory to do work which ought to be done in an industrial laboratory. Any proposal, therefore, to meet the conditions of the problem must remove all thought of personal reward to the individual making the invention so that he shall remain in the same mental state as heretofore. This can readily be accomplished if it is understood that the inventions are to be assigned when the applications are filed and that all proceeds are to be applied to the expansion of research and general research facilities under the exclusive control of the head of the department.

On the other hand, the patenting of these inventions would have a highly beneficial effect in increasing the immaterial rewards of those engaged in research. Patents must issue in the name of the actual inventor and if the time ever comes when many of our great industries are paying tribute for the use of patents issued upon the inventions of our university faculties, industry will have driven home to it in a most forceful fashion the importance and value to a community of a trained research professor. Instead of being looked at askance by business as a cloistered theorist he will of necessity be respected as a builder of foundations. We all realize that our genuine scientists are too little appreciated by the community at large and there is no way in which the public judgment can be rectified so readily as by direct attack on the public pocketbook.

Plan of Organizing the Patent Work

It has been suggested that the universities would not desire in their corporate capacity to take over and own the patents negotiated for licenses and perhaps conduct suits. Possibly in the future this view might be changed and in a decade or two it might be understood that it was as much a part of the duties of the business manager to administer patent property as to administer real estate. It is supposed the university would accept the gift of a valuable patent the same as that of a piece of real estate, and would administer it in the same business fashion, and it might well be that in due time it would be appreciated that the business manager ought to administer this property the same as any other. However, initially, and if desired, permanently, there is no need for the university to appear in the matter at all. A few friends of the university having no connection with the board of trustees or with the faculty can

readily organize a trustee corporation not for pecuniary profit. These patents can be taken over by this holding company; it can grant the licenses, collect the royalties and pay over the proceeds to the university as a trust fund for the furtherance of research. In this respect the holding company would stand to the university precisely as does any other donor, would administer the patent property according to its best judgment and would turn over the proceeds without limitation as to the manner of expense by the university, or to be used in gifts for special purposes. If at any time the university should decide to administer the property direct, it could all be turned over to the university in its corporate capacity, but until that time the university would have no responsibility.

This leads naturally to the question of the manner of administration and the expense thereof. The ordinary investigator has no idea of the limits to which patent protection can extend and in most cases has no appreciation of the fact that he has made patentable inventions. Furthermore he is incapable by training and education of picking out the patentable from the unpatentable part of his work, so that this would have to be done for him by someone else. The only feasible arrangement is to have the papers, thesis and results of investigation reviewed by a patent counsellor sufficiently versed in chemical and physical matters quickly to grasp the situation, and to have counsel segregate the patentable matter and prepare and file patent applications. If the plan should succeed and an enormous research organization be built up, this work would require the services of several trained men, but the expense could be borne without difficulty by the holding company out of its proceeds, for the expense of drawing and soliciting patents would necessarily be an insignificant feature. In initiating the plan the work involved is relatively small, because relatively little research is being done. The comparatively insignificant government fees for patent applications can be taken care of by friends of the plan and of the university, without costing the university any money. If a plan of this sort should be generally adopted for universities, it would be quite feasible to secure the patent services of the alumni to an extent sufficient to make each of the plans become self-sustaining without expense.

Cause for Litigation Removed

As to patent litigation, there probably would be none. No case is known where a patent thrown open so that all the world could have it upon a payment of a reasonable royalty was deliberately infringed by manufacturing concerns. They all prefer to pay a royalty rather than to take chances of litigation. A few patents, usually on processes which can be practiced in every shop, have been extensively infringed even though licenses were cheap and available, but these cases have been exceptional in that each infringement was trifling in extent, but the number was very great. This occurred in the case of the driven well patent and some dental process patents where there were thousands of users of the invention. In the ordinary case the infringer has a more substantial interest in the invention and would prefer to be a licensee on reasonable terms. Furthermore the fact that the license fees would be paid over to an educational institution would lead industry to treat these patents most kindly and it would be surprising if litigation ever occurred. The Cottrell patent above mentioned has never been litigated and doubtless never will be, because the fees are reasonable, are equal between like users and are applied to the furtherance of research.

Founding Special Research Fellowships

There are two other questions which have been thoroughly discussed, both involving the case where an outside party desires the university to undertake a particular piece of research and is willing to contribute to the expense, as by founding a fellowship. Of course at the outset it must be understood that the head of the department involved is to decide on the scientific lines only whether this piece of research is worth while, and he should not permit himself to be influenced by any commercial consideration. Sometimes the suggested line will be of great scientific value, and yet the investigation will be of the utmost commercial value to the donor. Inventions made in research under these circumstances will be of two kinds.

The first will be the rarer, where the donor of the fellowship is a skilled chemist or physicist himself and is able to direct the investigation in detail by suggesting specific things to be done. In this case the donor would be the true inventor, he having made the suggestion of definite procedure to be followed. Since, however, the facilities of the university are employed in the investigation, it would seem equitable that the university might insist upon a division of the proceeds, and it is suggested that in cases of this kind the university might properly insist that the inventions should be held for public use and that the proceeds be divided upon some fair basis. In one case now in the chemistry department of a university the donor of a fellowship has actually suggested and mapped out many of the experiments which have been made. He would have a legal right to patent these inventions in his own name and give the university nothing, but is perfectly satisfied to divide the proceeds equally, the university's share to be employed in the furtherance of chemical research. There seems to be no reason why the university should not accept such an arrangement, more particularly since it has now no rights whatever in the premises, and it certainly should not be hindered from making an interesting scientific investigation merely because the investigation is on the scientific truths underlying an invention or inventions already made by the donor.

In the more common case the donor of a fellowship would not have the scientific knowledge to map out the work in detail, but would only want a broad line investigated. Here the donor would not be legally the inventor, but the inventions, if any, would be those of the fellow or other investigator. Under those conditions an arrangement such as that offered by the donor above mentioned should be highly satisfactory. The question of the technical inventorship should not change the proposition and the donor of a fellowship should have a broad consideration in the commercial proceeds therefrom.

It is probable that as time goes on, if a broad plan works out, the research departments may not need to ask or accept fellowships at all, for after a decade or two of development the departments might be entirely self-sustaining. At the present time, however, when the departments are in serious need of expansion, it seems that the accepting of fellowships under these general conditions would be highly desirable.

Legal Notes

By Wellington Gustin

Verbal Promise by Salesman Not Binding, Especially When Promptly Repudiated

In a recent case where the Pocahontas Guano Co. had brought action against a dealer and another it was said the unauthorized contract of the company's salesman was ineffectual when promptly repudiated by the company.

The action arose out of a consignment of fertilizer to defendant for sale as agent of the company. Notes were given to the company in settlement of the fertilizer consigned to and sold by the agent. The agent testified on trial that he had sent the notes in a letter claiming that they were sent without prejudice to his right to recover damages for an alleged breach of a verbal contract made with him by a salesman of the Guano company to ship him another carload of fertilizer for his own use. By reason of the failure to do so he had sustained damages to his crop, for which he set up a counterclaim for damages against the company's suit for balance due in the notes. On trial the agent was given a verdict on his counterclaim, and judgment for the balance over the company's claim was entered. From this judgment the company appealed.

Written Contract Barred Verbal Promises

The Supreme Court of North Carolina has reversed this judgment. It said there was not sufficient evidence to go to the jury in support of the counterclaim made by the dealer-agent. The contract between the company and the agent was in writing and was for shipment of fertilizer to be sold as agent. This contract contained the clause, "No verbal promises that conflict with the terms of this contract will be recognized by this company."

Subsequently to the above consignment the agent ordered another carload of fertilizer for his own use. The company did not ship, but sent its salesman to see the agent, who testified that he still had thirty or forty bags of fertilizer on hand which he had received as consignee and agent. He further testified that the salesman told him to sell these bags and he "would see that he got another carload."

On the other hand, the agent put in evidence a telegram and letter from the company and its salesman, acknowledging receipt of a telegram and letter from the agent, but stating that owing to prior orders the company was unable to accept the agent's order for another carload of fertilizer. The court said this showed a case where the defendant ordered a carload of fertilizer, which order the company declined to accept and fill. It did not appear from the evidence that it was in the scope of the agency of the company's representative to bind it to ship the fourth carload.

His Order Refused by the Company

When he reported the order to the company he was promptly notified that the company could not accept and fill the order, and the agent was not misled by any reliance upon his order being filled. The court says he had no right to rely upon the unauthorized statement of the agent, if made, that if he, the defendant, sold the thirty or forty bags which he had on hand for sale as agent, he "would see that a carload was shipped to the defendant for his own use." The contract defendant held showed no agreement was binding until countersigned by an officer of the company, and the company as well as salesman promptly notified the agent by letter and wire that owing to the scarcity of fertilizer and prior orders, his order could not be accepted.

Government Need Not Pay for Product It Destroys Under Act of Congress of March 4, 1915

In the case of the Great Western Serum Co. against the United States, decided adversely to the Serum company in the Court of Claims, the Supreme Court of the United States affirmed the judgment of the lower court.

The Serum company sued to recover the value of anti-hog cholera serum, anti-cholera virus and serum blood, seized without agreement to purchase by agents of the Bureau of Animal Industry in November, 1914, and thereafter destroyed.

The act provided that in case of an emergency arising out of certain contagious diseases of animals which threatened the live stock industry of the country the Secretary of Agriculture may expend the sum of $2,500,000, then appropriated, "in the arrest and eradication of any such disease, including the payment of claims growing out of past and future purchases and destruction, in co-operation with the states, of animals affected by or exposed to, or of materials contaminated by or exposed to, any such disease wherever found and irrespective of ownership, under like or substantially similar circumstances, when such owner has complied with all quarantine regulations, and said sum shall be immediately available for the purposes specified."

The Supreme Court ruled that there was no purchase of the destroyed product or agreement therefor, and none was claimed, and that the act does not itself raise an implied contract by the United States to pay for the property so destroyed; and therefore an owner of materials contaminated by or exposed to such disease and destroyed by Government agents cannot sue for its value where there was no purchase or agreement to purchase the property destroyed.

Creditor's Knowledge Relieves Stockholder in Corporation From Liability Under Georgia Laws

In an action between the Farmers' Warehouse & Fertilizer Co. and the Macon Fertilizer Works the Supreme Court of Georgia has held that a creditor of a corporation who knows that the requisite amount of capital stock has not been subscribed may not proceed to collect a bill by an action against a subscriber, under the Georgia laws. The Civil Code (1910), section 2,220, says:

"Persons who organize a company and transact business in its name before the minimum capital stock has been subscribed for are liable to creditors to make good the minimum capital stock with interest."

Now the Supreme Court in this case has said that if at the time credit is extended the creditor knows the fact that the requisite amount of capital stock has not been subscribed, he cannot claim or be said to have been misled, and relatively to him the subscriber to the stock would not be stopped from pleading such knowledge as a defense to a suit based on the above section of the statute. (148 Ga., 388.)

Removal of Arsenic From Zinc Electrolyte by Means of Hydrogen Sulphide

This Article Describes Large-Scale Generation of Hydrogen Sulphide and Using It to Precipitate Arsenic From Electrolyte—The Acid Used for This Generation Is Completely Consumed and the Gas Is Completely Utilized in Precipitating Arsenic

By HERBERT R. HANLEY*

THE economical operation of an electrolytic zinc plant is partly dependent upon the practically complete removal from the electrolyte of all metals more electro-negative than zinc. Where these metals are present in relatively small amounts, this can be done by precipitation upon metallic zinc. Arsenic in the form of arsenites can be removed economically, if present not in excess of 1 or 2 g. per liter, by precipitation by means of lime as iron arsenate. If present in larger amounts, some other means must be depended upon, as the above-mentioned methods are then impractical. The problem of treating the arsenical zinc-fume which had accumulated at the Mammoth plant of the United States Smelting, Refining & Mining Co. at Kennett, Cal., for the recovery of zinc and cadmium presented a particularly interesting problem.

This bag-house fume when first collected contained the arsenic in the trivalent form as arsenites of the various metals. Because of the voluminous nature of the fume it was necessary to collect it under water. This resulted in the breaking down of the flocculent deposit that would otherwise be obtained. The coalescence of the solids produced a mud, or slime, of a normal specific gravity. During the storage of the bag-house mud a gradual oxidization of the arsenic occurred, with the result that after a few years' storage approximately half of the arsenic was present in the pentavalent condition. The solution of this mud in dilute sulphuric acid naturally produced a certain amount of zinc arsenate. This is soluble in slightly acid solutions at moderate temperatures; at temperatures above 60 deg. C., however, it coagulates, forming a gelatinous translucent precipitate, the completeness of the reaction varying inversely as the acidity. Also, if the slightly acid solution of zinc arsenate be neutralized with any base, there is obtained a very voluminous and gelatinous precipitate which cannot be washed free from soluble zinc salts. When solutions containing arsenates are treated with hydrogen sulphide for the precipitation of the arsenic, the consumption of this gas is uneconomical, a portion of the hydrogen sulphide being reduced to sulphur; in addition, this operation required an inordinate length of time.

These conditions make it impractical to consider the precipitation of the arsenic from this solution with hydrogen sulphide, and it is evident that for the economical recovery of the zinc some method must be devised whereby the losses entailed in the handling of the precipitates are avoided.

These difficulties practically disappear if the arsenic be present in the trivalent condition: no insoluble compound of zinc and arsenic is formed during neutralization; the precipitate produced may be easily washed; the consumption of hydrogen sulphide is normal. Preliminary to the removal of the arsenic from the fume by means of hydrogen sulphide it became necessary to develop an economical process for the reduction of the arsenic to the trivalent condition.

This problem was solved in a practical manner by circulating the solution through a tower through which sulphur dioxide gas is passing. The tower is 2 ft. square, 30 ft. in height. The sulphur dioxide gas is produced by a pyrite burner. It was found that the reduction takes place in cold as well as hot solutions. This is probably due to the relative solubility of sulphur dioxide in hot or cold solutions of zinc sulphate. While the rate of the reduction may be greater in hot than in cold solutions, the greater solubility of sulphur dioxide in the latter accomplishes the reduction in approximately equal times under average conditions.

The reduction of 1,000 lb. of arsenic in the solution which contains about 10 g. of pentavalent arsenic per liter requires the pumping of this solution through the tower at the rate of 225 gal. per minute for sixteen hours. The consumption of sulphur dioxide is approximately 4.4 lb. per pound of arsenic reduced.

In Table I is shown a record of experiments in the reduction of the arsenic in the zinc sulphate solution obtained upon leaching the bag-house fume with sulphuric acid. This solution contained approximately 6.0 g.p.l. H_2SO_4, 96.0 g.p.l. Zn, 4.0 g.p.l. Cd, 0.5 g.p.l. Cu and 8.9 g.p.l. As^v.

TABLE I

Test No.	1	2	3	4	5	6	Av.
Gal. solution treated	947	514	950	500	840	516	711
Temp. solution, deg. C.	30	30	30	50	58	69	44.2
G.p.l. As v before treat.	10.2	7.8	8.0	9.8	8.0	9.8	8.93
G.p.l. As III before treat.	11.8	10.3	9.0	11.4	10.1	7.4	10.00
G.p.l. As v after treat.	0.0	0.3	0.5	0.8	0.5	1.8	0.78
G.p.l. As III after treat.	24.0	18.6	17.5	21.8	18.0	18.8	19.78
Pounds arsenic reduced	80	31	59	38	51	35	49
Pounds SO_2 delivered to base of tower	210	216	252	219	160	146	200.5
Pounds SO_2 delivered to base of tower per hr.	42	72	48	73	35	40	50.0
Time required, hours	5.0	3.0	5.2	3.0	4.5	3.4	4.0
Per cent SO_2 in gas by volume	5.8	8.0	6.2	8.0	4.0	5.5	6.25
Pounds SO_2 per pound As^v reduced	2.6	5.8	4.2	5.7	3.0	4.0	4.44
Gal. solution circulated per minute	120	70	40	120	40	40	72
Pounds SO_2 per sq.ft. grate area per hour	8.4	14.5	9.6	14.6	7.0	8.0	10.35

Generation of Hydrogen Sulphide

Two methods were considered for the generation of hydrogen sulphide: First, the distillation of oil with sulphur, a method formerly used for the production of

*Mining and metallurgical engineer, Bakersfield, Cal. Formerly superintendent, Mammoth electrolytic zinc plant, United States Smelting, Refining & Mining Co., Kennett, Cal.

asphalt from oil; and, second, the reaction of dilute sulphuric acid on low-grade copper matte. Under the local conditions which obtained at Kennett the sulphur-oil method proved to be more expensive and in general less promising of practical application than the sulphuric acid-copper matte process. With more favorable conditions the sulphur-oil method might, however, prove economical.

Sulphur-Oil Method

In general, the sulphur-oil method consists in slowly distilling oil with sulphur at a temperature between 150 and 200 deg. C. To obtain maximum production of hydrogen sulphide from the sulphur it is necessary to use an oil of definite physical properties. If asphalt is to be made as a byproduct, the sulphur must not exceed 10 per cent the weight of the oil. The distillation of an oil with sulphur in excess of 10 per cent will, as a rule, produce a residue quite similar to coke. If the nature of the residue is immaterial, the amount of sulphur may be increased to 50 per cent of the weight of the oil with satisfactory results as regards the yield of hydrogen sulphide. The maximum yield of gas is, however, not much in excess of 80 per cent of the theoretical obtainable from the amount of sulphur used.

TABLE II.

Test No.	Temp. Deg. F.	Kind of Oil	Per Cent Weight of Sulphur to Weight of Oil	Hours Distilled	Per Cent Sulphur Converted to H_2S	Per Cent Weight of Asphalt to Weight of Oil
1	150–205	A	10	19	48.0	†
2	150–163	A	10	24	51.5	80
3	150	A	25	18	52.0	†
4	150–205	A	50	8	54.1	†
5	150	B	10	18	52.0	90
6	150–205	B	25*	23	7.8	†
7	150–205	A-1	10	7	73.7	90
8	150–205	B-1	10	10	50.0	90
9	150–205	A-2	10	11	82.1	84
10	150–205	C	10	9	60.0	94
11	150–205	D	10	7	60.0	†
12	150–205	E	10	3.5	72.2	†
13	150–205	2 pts. E 1 pt. D	10	8	45.2	†

* In the form of pyrite.
† Residue in the form of coke.
A. "Fuel oil" from Coalinga district, California.
A-1. Same as A distilled with live steam and outside heat; 11.3 per cent, by volume, distillate removed.
A-2. Same as A-1 further distilled with live steam and outside heat; 57 per cent, by volume, distillate removed.
B. Fuel oil from Shell district, California.
B-1. Same as B, distilled with live steam and outside heat; 18 per cent, by volume, distillate removed.
C. Cylinder oil stock.
D. Residuum obtained from the manufacture of road oil by the distillation of the fuel oil.
E. Road oil.

Results of Tests

The results of a series of tests are shown in Table II. The maximum conversion of 82 per cent of the sulphur to hydrogen sulphide in test 10 was obtained on a specially prepared oil. To obtain a similar yield in commercial-scale operation at the Kennett plant would have required co-operation with an oil-refining company for the supply of an oil-residue with these particular characteristics.

Sulphuric Acid Matte Method

As is well known, hydrogen sulphide can be generated by the action of dilute sulphuric acid on the iron sulphide contained in matte. In order that this method may be used commercially it is not only necessary to obtain economical consumption of sulphuric acid but also necessary that the generating apparatus be safe in operation. A low-grade matte was available at Kennett of the following composition: Cu 10.0 per cent, Zn 3.5 per cent, Fe 54.0 per cent, S 28.0 per cent, insoluble 1.2 per cent, undetermined 3.3 per cent. In order to determine the ratio of the amount of acid consumed to the amount of hydrogen sulphide generated when this matte was treated with dilute sulphuric acid, seven 100-g. samples were treated with different amounts of acid, as shown in Table III. The residue was analyzed for copper, zinc and iron and the quantity of hydrogen sulphide liberated was determined.

The result of these tests brought out the fact that acid to the amount of 75 per cent of the weight of the matte is required to liberate the maximum quantity of hydrogen sulphide and that approximately 5.5 lb. sulphuric acid is required for each pound of hydrogen sulphide produced. Acid to the amount of 10 per cent of the weight of the matte is consumed by "acid-consuming" constituents of the matte before any hydrogen sulphide is liberated. This fact would make it economical to continue the treatment of the matte with acid until the maximum amount of hydrogen sulphide had been produced, varying somewhat due to local conditions.

Resistance of Matte to Acid Treatment

The treatment of matte with dilute sulphuric acid will not liberate hydrogen sulphide under all conditions. It was found that the physical condition of the matte, method of granulation, and the flux used in its production were factors that determined this characteristic. The results of investigations to control these conditions brought out the following facts:

(1) High-grade mattes containing more than 20 per cent copper are usually active regardless of the furnace flux or the method used to reduce the matte to a granulated form.

(2) Low-grade mattes containing about 10 per cent copper are usually active when the furnace flux consists of clean quartz, regardless of the method used to reduce the matte to a granulated form.

(3) Low-grade matte containing about 10 per cent copper is usually inactive when the furnace flux consists of country rock, such as silicified rhyolite containing aluminum silicate. When this matte is granulated in water, however, it is active, but it loses this activity if allowed to become dry. This activity is retained indefinitely if the matte is kept immersed in water.

TABLE III.

Cycle No		1	2	3	4	5	6	7	Total or Av.
Grams H_2SO_4 used	...	10.4	11.75	11.75	11.75	11.75	11.75	6.2	75.40
Weight of matte residue after each acid treatment	....	92.5	84.5	75.0	62.6	55.0	45.5	35.0	.....
Analyses of matte residue:									
Cu %	8.7	9.3	10.3	11.7	12.8	15.8	16.9	23.4	.....
Fe %	54.2	52.0	48.8	46.2	42.6	39.6	34.7	33.4	.....
Zn %	3.0	3.2	3.7	4.3	4.8	5.4	6.5	7.7	.....
S %	27.5	28.5	28.0	28.0	29.3	28.7	27.4	29.0	.....
Grams iron lost by matte		6.0	6.9	6.6	8.0	4.9	6.0	4.0	42.40
Grams sulphur lost by matte		0.6	2.8	2.6	2.7	2.6	3.2	2.3	16.8
Grams H_2S generated		None	2.27	2.34	2.40	2.63	2.53	1.68	13.85
Grams H_2SO_4 consumed per gram H_2S generated		....	5.17	5.00	4.88	4.46	4.65	3.68	5.44
Grams iron dissolved per gram H_2S generated		....	3.03	2.82	3.33	1.86	2.37	2.38	3.03

By meeting these conditions it was possible to keep on hand a dependable supply of matte for use in the generation of hydrogen sulphide.

Apparatus for the Generation and Use of Hydrogen Sulphide

In the development of the process the apparatus used for the production of hydrogen sulphide consisted of a standard creamery churn, 4 ft. in diameter and 4 ft. in length, reinforced by the addition of double heads. The generator is supported on trunnions and may be rotated when desired. The gas outlet and the gas and acid inlet are inserted axially through stuffing boxes. The gas outlet pipe is connected to a Roots blower which delivers the gas to the precipitating tank. This tank is provided with a sealed top and pipes through which the gases may be circulated. The general layout of the apparatus is shown in Fig. 1. The matte is charged into the generator from the bin 1. Dilute acid is admitted from the storage tank 2, the amount of acid added being measured. A bin 7 is provided for the generator residue which is dumped into car 8 for disposal. The gas passes through a separator 4 to the Roots blower 11, which delivers the gas to the precipitating tank 16 through a perforated coil of pipe located about midway the depth of the tank, this particular location being important, as will be shown later. A blower 14 circulates a portion of the attenuated gas through the precipitating tank, delivery being at the bottom of the tank through a perforated coil of pipe, thereby causing a thorough agitation of the arsenical

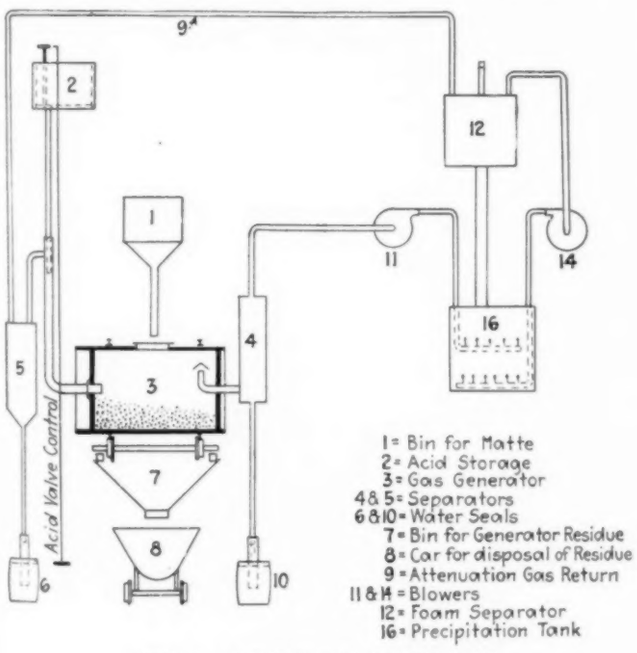


FIG. 1. LAYOUT OF APPARATUS

solution. The impoverished gas which is forced through the solution in the precipitating tank by the blower 11 returns through pipe 9 and separator 5 to the generator. This arrangement is not only economical in the use of hydrogen sulphide but by preventing the escape of the gas to the atmosphere renders the operation safe. A drum 12 separates the froth from the gases. The circulation systems are closed except for safety seals 6 and 10 and a relief valve. These are located outside of the building. The generator operates under a slight vacuum which not only accelerates the generation of the hydrogen sulphide but also assists materially in preventing its escape into the atmosphere of the room.[1]

It was discovered that there would be a precipitation of zinc sulphide due to a local depletion of the arsenic in the solution if the gas from the generator was delivered to the blower 11 at the bottom of the precipitating tank. This precipitation of zinc sulphide is prevented by the delivery of the gas from the generator at the zone of maximum agitation caused by circulating the attenuated gas by means of blower 14.

Details of Operation

One thousand pounds of granulated matte is introduced from the storage bin through the manhole of the generator and the cover is closed. The blower 11 is started and 50 gal. of dilute sulphuric acid (200 g.p.l.) added from the tank, this amount being sufficient to take

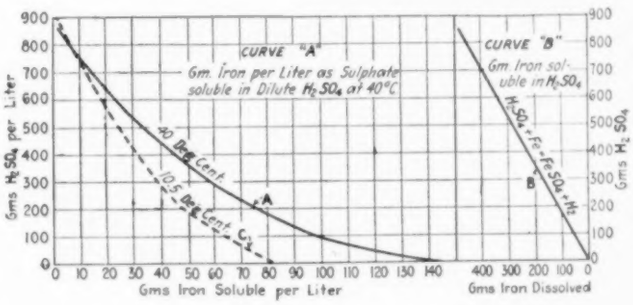


FIG. 2. SOLUBILITY OF IRON IN SULPHURIC ACID

care of the initial consumption of acid. The addition of acid is then continued at the rate of about 50 gal. per hour, with an occasional rotation of the generator, until there is a diminution of the rate at which the gas is generated. The rotation of the generator causes the inert coating on the particles of matte to be removed by attrition, increasing the rate at which the hydrogen sulphide is liberated. When an amount of acid has been added which is calculated to liberate the maximum amount of hydrogen sulphide from the matte, the generator is rotated continuously until this acid is neutralized. The solution from the generator is removed by decantation and the matte residue dumped from the generator through the manhole.

Importance of Using Dilute Sulphuric Acid of Correct Strength

It is important that the dilute sulphuric acid be of such strength that complete neutralization will not form a saturated solution of sulphates at the operating temperature of the generator, otherwise a crystallization will take place within the generator. The formation of a saturated solution also causes a loss of acid. Dilute sulphuric acid containing 200 g. per liter will react with iron, producing a solution containing 120 g. iron per liter. This amount of iron in the form of iron sulphate is soluble in dilute sulphuric acid containing not more than 40 g. per liter, if the temperature of the solution is not less than 40 deg. C. This temperature is lower than the normal operating temperature of the generator.

The importance of using a dilute sulphuric acid of correct strength may be illustrated by the following example: Suppose the dilute acid contained 300 g. per liter H_2SO_4. Referring to Curve *B*, this amount of acid will dissolve 170 g. of iron. Referring to curve *A*, it is

[1] U. S. Patent 1,360,521; Nov. 30, 1920.

TABLE IV.

Lot No.	1	2	3	4	5	6	7	8	9
Gal. treated	362	410	498	433	455	450	424	402	392
Sp.gr. sol. before treatment	1.25	1.26	1.26	1.22	1.24	1.24	1.24	1.24	1.225
Sp.gr. sol. after treatment	1.22	1.21	1.22	1.21	1.25	1.23	1.25	1.22	1.21
G.p.l. ZnO before treatment	84.7	91	90	94	88	91.5	92	90	84
G.p.l. ZnO after treatment	86	94	92	104	90	93.0	94	91	85
G.p.l. As before treatment	24	18.4	25	16	16.5	17.2	15.3	15.8	15
G.p.l. As after treatment	1.1	0.2	0.1	0.7	0.8	1.2	1.2	1.2	0.5
Pounds As pptd.	68	75	105	56	59.5	60	51.6	50.3	48
Pounds H_2SO_4 used in generator	352	236	600	277	293	30.2	209	218	204
Time of treatment, hours	10	4.5	10	8	5	5	4	4	4.6
Pounds H_2SO_4 used per pound arsenic, pptd.	5.2	3.1	5.6	4.9	4.7	5.0	4	4.3	4.2
Analysis of ppt.:									
Arsenic, per cent	40.0	41.0	48.0	48.0	46.0	48.0	42.0	41.0	45.6
Insol. Zn, per cent	5.0	9.0	9.0	5.0	6.0	5.0	5.0	3.2	4.0
Cadmium, per cent	4.0	3.9	4.2	4.5	5.0	4.5	4.1	3.8	4.0
Copper, per cent	1.0	1.1	1.2	1.2	1.2	1.1	1.0	1.1	1.0

to be noted that a maximum of 145 g. of iron per liter is soluble in a solution containing no sulphuric acid. The difference between this maximum solubility and the amount of iron which would be dissolved by 300 g. of H_2SO_4 amounts to 25 g. iron per liter, which is equivalent to 43½ g. of sulphuric acid, and represents the amount which would be wasted if this strength were used.

Precipitation of Arsenic

The precipitation of arsenic is accomplished in a solution containing not less than 10 g.p.l. H_2SO_4. This is necessary in order to prevent a simultaneous precipitation of zinc sulphide. The use of a more dilute solution is attended with an increasing precipitation of zinc sulphide; the use of stronger solutions not only results in the unnecessary loss of acid but also increases the amount of the precipitate produced upon the subsequent neutralization of this solution with lime rock and the expense necessary to handle it.

For the precipitation of one ton of trivalent arsenic there is required approximately 12 tons of matte and 4.5 tons of sulphuric acid. The matte residue will amount to about 8 tons and will contain practically all the copper of the original matte. The strength of the generator gas will vary between 0.5 and 8 per cent, depending upon the rate at which acid is added and also upon the activity of the matte.

Results obtained in treating the arsenical zinc solution are shown in Table IV. The amount of sulphuric acid used is calculated on the weight of arsenic precipitated, as this is the element which made necessary the treatment of the solution. Since the complete removal of the arsenic will cause the precipitation of zinc as sulphide, about 1 g. per liter of arsenic is left in solution. The precipitates obtained from lots 2 and 3 are high in zinc for this reason.

The arsenical precipitate is removed from the zinc solution by filtration. A plate and frame filter press is used, no difficulty being experienced in handling and washing the precipitate. It is uneconomical to wash the cake beyond the point where the water soluble zinc is less than 5 per cent.

Removal of Last Traces of Arsenic

The last traces of arsenic are removed by precipitation as an iron arsenic compound from a solution containing iron in excess of the amount required to form this compound, the precipitating agent being pulverized lime rock. This operation also results in the complete removal of the iron. The solution after the removal of the iron precipitate by filtration is given the usual treatment for the removal of cadmium and traces of other metals which may have escaped the previous treatments. It is to be noted that the complete removal of cadmium with hydrogen sulphide is impracticable, since it is necessary to perform this precipitation in a nearly neutral solution, in which case there is simultaneous precipitation of zinc. The cadmium is removed by filtration and the solution delivered to the electrolytic zinc cells. The zinc cathodes produced are of excellent quality.

Generators holding 8 tons of matte have been designed, and consist of cylindrical wood drum, lead lined, and with an inner wood covering to protect the head from abrasion. This is supported in a manner similar to revolving driers, with circular track and bearing wheels.

This apparatus was operated over a period of ten months with satisfactory results; there were no accidents due to the use of hydrogen sulphide and no deleterious effects experienced by the workmen in or about the plant. This demonstration of the practical use of hydrogen sulphide in large-scale work may open up new fields of usefulness, removing this gas from the class of laboratory reagents. There is a possibility of its use for the sulphide coating of ore particles preliminary to recovery in flotation machines and as a reagent to assist in the selective flotation of complex ores. Its more extensive use in the chemical and metallurgical field may come about as a result of the success of this installation.

San Francisco, Cal.

Preparation of Pure Platinum

It is reported that the Bureau of Standards has recently succeeded in producing platinum of higher purity than any obtainable from the platinum dealers in this country or abroad. The "normal thermo-element platinum" of W. C. Heraeus has long been accepted by scientific laboratories as the standard for use in platinum resistance thermometers, thermocouples and other equipment requiring platinum of the highest possible purity. The platinum prepared by the bureau appears to be of a better quality than the best of the Heraeus wire to which the bureau has had access.

It was found that the Heraeus platinum, although free from other platinum metals and the usual base metals, contains small amounts of calcium. By careful control of the operation of melting, which is usually done on lime, the bureau has prepared platinum containing no more than a trace of this element. It was noted also that calcium, even when present in very small quantities, has a considerable effect upon certain of the physical properties of platinum.

The bureau purposes to make a further study of the best conditions for melting platinum on lime and will also investigate the suitability of other refractories.

Synthesis of Chlorine-Free Benzoic Acid From Benzene—II

Influence of Reaction Conditions on the Yield of Benzonitrile in Fusions of Benzene Sulphonate and Sodium Cyanide—Variation in Composition of Charge, Reaction, Temperature and Pressure*

BY RALPH H. McKEE AND FRANK A. STRAUSS

THE chief conditions capable of variation in the benzonitrile reaction are: The composition of the charge, the reaction temperature, and the pressure.

The composition of the charge may be varied in three ways: By changing the proportion of cyanide to sulphonate, by the substitution of salts other than sodium salts, by the addition of other substances to the charge. All three methods of variation were investigated.

CHANGES IN THE RATIO OF CYANIDE TO SULPHONATE

The original method of Merz makes use of equal parts of cyanide and sulphonate. As the theoretical ratio is 1 part NaCN to 3.67 parts $NaSO_3C_6H_5$, it will be seen that Merz' mixture contained a large excess of cyanide. As the cyanide is the more expensive constituent, it is important to limit its use as much as possible.

A series of runs was made in which the proportion of cyanide to sulphonate was varied. The results are given in Fig. 3.

The experiments indicated the following general relations:

When cyanide is in excess, the time of reaction is

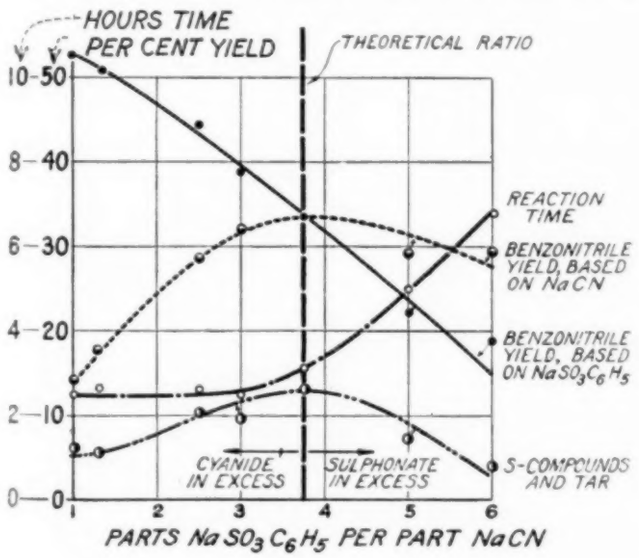


FIG. 3. EFFECT OF VARYING RATIO NaCN : $NaSO_3C_6H_5$

practically independent of the composition of the charge. When sulphonate is in excess, the time of reaction increases approximately in proportion to the added sulphonate.

The yield of benzonitrile based on sulphonate decreases progressively as the proportion of sulphonate increases.

The yield of benzonitrile based on cyanide at first increases as the proportion of cyanide increases. It reaches a maximum with equimolecular proportions and after that falls off slightly.

The yield of volatile sulphur compounds and tar

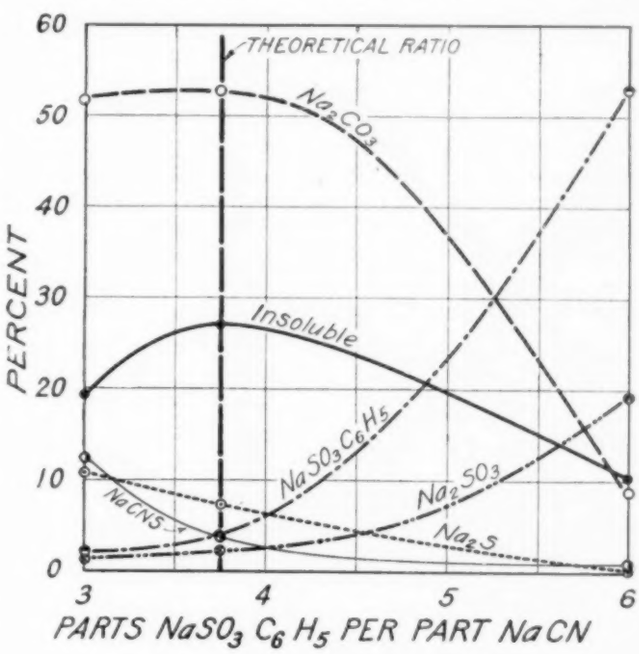


FIG. 4. ANALYSIS OF RETORT RESIDUE

is a maximum when equimolecular portions are employed. The figures are somewhat irregular because of the difficulty of collecting the tarry residue quantitatively.

These results may be interpreted somewhat more satisfactorily with the aid of the analyses in Table II.

TABLE II. ANALYSES OF RESIDUES FROM RETORT
Temperature 430 deg. Atmospheric Pressure

	Ratio Cyanide: Sulphonate		
	1:3.00	1:3.75	1:6.00
Na_2CO_3	49.9	54.2	8.4
Na_2SO_4	2.5	2.5	1.9
Na_2SO_3	1.2	2.1	19.1
Na_2S	10.7	7.2	0.3
NaCNO	1.9	1.0	1.3
NaCNS	12.4	3.8	1.0
NaCN	0.0	0.0	0.0
$NaSO_3C_6H_5$	1.9	3.9	50.2
Insoluble (carbon)	18.5	27.9	9.9
$Na_4Fe(CN)_6$	....	.....	1.7
FeO	....	.....	1.0
	98.9	102.6	94.8

The variations in the principal components of the residue are plotted in the form of curves in Fig. 4.

From a study of the curves, the following conclusions may be drawn:

*For Part I see CHEM. & MET. ENG., vol. 24, No. 15, p. 638, April 13, 1921.

The products of reduction—sodium carbonate, sodium sulphide and sodium thiocyanate—are formed in smaller proportion as the proportion of sulphonate increases.

The percentage of sodium sulphite, the normal product of the benzonitrile reaction, is small when cyanide is in excess, but increases rapidly as the excess of sulphonate increases.

The percentage of insoluble (carbon) first increases and then decreases as the proportion of sulphonate increases, paralleling closely the curve for sulphur compounds and tar in the distillate. This indicates that the carbon and the sulphur compounds and tar are formed by the same action—namely, by pyrogenic decomposition, or "cracking."

As long as an excess of cyanide is present the sodium benzene sulphonate in the mixture is decomposed almost completely. When an excess of sulphonate is present, however, a large amount will be found undecomposed in the residue. The excess sulphonate serves largely as a diluent, and this dilution seems to result in a smaller amount of undesired reduction and decomposition. The full significance of this dilution will be shown when the effect of temperature is considered.

Taken together, these results indicate that when cyanide is in excess the predominating side reactions are those due to its reducing action; as equimolecular proportions of the reacting material are approached, thermal decomposition becomes the predominant side reaction; while when an excess of cyanide is present the excess serves as an inert diluent and side reactions are repressed to a considerable extent.

The Use of Salts Other Than Sodium Salts

It is possible to effect substitutions for either the sodium benzene sulphonate or the sodium cyanide in the charge. Both types of substitutions were tried.

As substitutes for sodium benzene sulphonate, the sulphonates of potassium, ammonium, the alkaline earths and the heavy metals suggest themselves. Potassium salts, because of their high price at the time of this investigation, would not be considered as a commercial possibility. The alkaline earth sulphonates almost invariably give smaller yields in this type of reaction.

The ammonium salt melts at a relatively low temperature.[72] For this reason it was thought that it might react with sodium cyanide at a low temperature. However, double decomposition was found to take place, volatile ammonium cyanide being formed, which sublimed out of the retort, leaving sodium benzene sulphonate behind. Lead, copper and zinc benzene sulphonates were found to decompose at low temperatures.

As substitutes for sodium cyanide, potassium cyanide and the ferrocyanides suggest themselves. The cost of the potassium salt again limited its possibilities. Sodium ferrocyanide, however, is cheap and would have the advantage over the simple cyanide of being relatively non-hygroscopic and non-poisonous.

A mixture of anhydrous sodium ferrocyanide and sodium benzene sulphonate was heated in the retort in the usual manner. No distillate appeared until the temperature within the retort reached 455 deg. At this temperature a small amount of oil came over, but on examination it was found to contain not more than a trace of benzonitrile. As this is about the temperature at which sodium benzene sulphonate begins to decompose,[73] it is evident that sodium ferrocyanide is non-reactive at this temperature.

Because of this unforeseen result, the work of Witt[74] was repeated. A mixture of 56 g. anhydrous potassium ferrocyanide and 144 g. sodium benzene sulphonate were heated to 430 deg. in the retort in the usual manner. The reaction took place as usual, but the yield of the benzonitrile was small (24.4 per cent based on sodium benzene sulphonate). The marked difference between sodium and potassium ferrocyanides in this reaction is interesting.

The Addition of Other Substances to the Charge

In all these runs the mass was apparently never in actual fusion during the reaction, but only sintered at the temperatures attained. It was believed that if the mass could be made to assume the liquid state, better yields could be obtained.[75] As has been shown, the use of easily fusible salts is not possible in this reaction. It seemed possible that the same results could be obtained by adding to the charge a third component which would lower the melting point of the mixture. Unfortunately there are few cheap salts of low melting point which will not react with one of the components of the charge. Sodium thiocyanate is satisfactory in this respect. However, the addition of sodium thiocyanate did not lower the reaction temperature and caused no appreciable change in the benzonitrile yield. The thiocyanate rendered the mass somewhat more fluid during the reaction, but on laboratory scale this was a disadvantage rather than an advantage, as the pasty mass resulting tended to clog the delivery tube of the retort. The addition of sodium hydroxide to the charge was found to cut down the benzonitrile yield appreciably, as might be expected.

Results from runs with a large excess of sulphonate indicated that good results might be expected from the addition of inert diluting material. As a diluent, common sand was selected on account of its cheapness and inertness. A discussion of the runs with added sand is postponed until the effect of temperature has been considered.

The Reaction Temperature

A series of runs under varying temperature conditions was made, using a mixture of cyanide and sulphonate 1:3 by weight. This proportion was found to be a convenient one, giving good yields with a short reaction time. The results of these runs are summarized in Fig. 5.

It will be seen that the reaction time decreased rapidly as the temperature increased. It was found that no reaction took place below 410 deg. Below 420 deg. it took place too slowly for definite measurement. The yield of benzonitrile fell off as the temperature increased above 430 deg. Thus temperature control within a narrow range is necessary to get good yields. The variation in yield of sulphur compounds and tar is of no special significance.

Fig. 6 shows the logs of the above runs plotted in the form of curves. The inside temperature of the retort, the outside temperature and the rate of distilla-

[72] 256 deg., Norton, *J. Am. Chem. Soc.*, vol. 19, p. 835 (1897).

[73] Norton, *loc. cit.*

[74] *Loc. cit.*

[75] *Cf.* also the work of Reid [*Am. Chem. J.*, vol. 43, p. 162 (1910)]. He investigated the formation of benzonitrile by the distillation of mixtures of benzoates and thiocyanates, and found that the use of easily fusible salts gave greatly increased yields.

tion have been plotted against time for each run. Only the first part of the log of each run is shown.

These curves are typical of a strongly exothermic reaction. In each case the inside temperature rose steadily until a point in the neighborhood of 410 deg. was reached. Here the reaction took place more rapidly so the heat liberated could be conducted away. Consequently the inside temperature rose above that of the heating bath. At the same time the evolution of gas and fume (volatile ammonium salts), which up to that time had been negligible, took place with great rapidity. The rush of gases in the case of the run at 440 deg. was so vigorous that the stoppers were blown out of the collecting train, and because of the violence of the

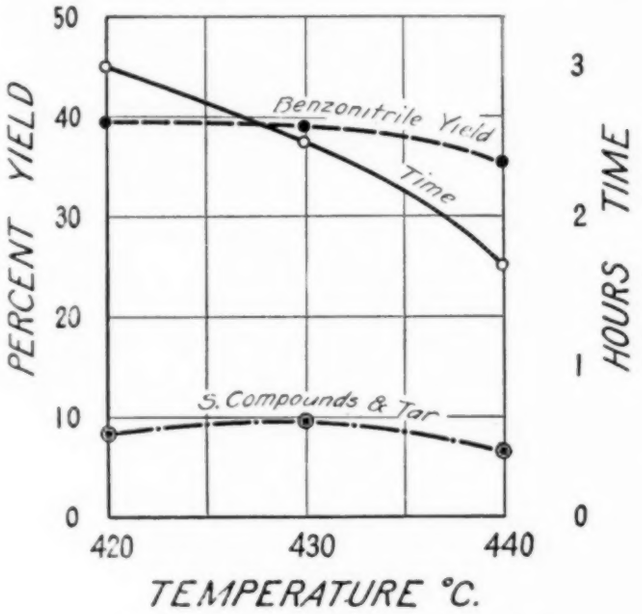


FIG. 5. EFFECT OF TEMPERATURE CHANGE. RATIO NaCN : $NaSO_3C_6H_5$ :: 1 : 3

reaction it was not thought advisable to go above this temperature. Simultaneously the rate of distillation, especially in the run at 440 deg., increased greatly.

These temperature curves are exactly similar to those obtained, for instance, on heating an alloy showing a "reaction point." The temperature at which the exothermic effect occurred was practically constant at a value close to 410 deg., which was previously found to be the minimum for the reaction. The reaction temperature may, therefore, be definitely fixed at 410 to 415 deg.

The heat of the benzonitrile reaction may be calculated from the data in the literature.[76] Following the usual notation,[77] the reaction may be written:

$NaSO_3C_6H_5$	+	NaCN	=	Na_2SO_3	+	C_6H_5CN	+	4.4 cal.
(solid)		(solid)		(solid)		(gas)		
—192.3		—22.6		—261.4		42.1		

The reaction, therefore, is exothermic to the extent of 4.4 large calories, based on thermochemical data for 20 deg. The actual heat of reaction at 420 deg. will, of course, differ slightly from this value. A rough calculation will show that this small heat effect is not sufficient to account for the marked temperature rise. The side reactions, therefore, must be responsible for a part of this unforeseen phenomenon. For example, the reaction:

$$2NaCNO\ (solid) + 3H_2O\ (gas) = Na_2CO_3\ (solid) + CO_2\ (gas) + 2NH_3\ (gas) + 14.5\ cal.$$

is quite strongly exothermic. It has already been shown that this is probably one of the side reactions. The oxidation of sodium cyanide to the cyanate by sodium benzene sulphonate is, no doubt, also exothermic. Hence the heating effect observed is not due to the main reaction alone, but to undesired side reactions as well.

The Effect of Addition of Inert Material

It is clear that the rise in temperature noted during the reaction is detrimental to the formation of benzonitrile, since, as has been shown, the yield falls off with increasing reaction temperature. The true significance of the effect of an inert diluent on the reaction now becomes apparent.[78] The dilution material can check the undesired temperature rise in two ways: By its heat capacity, and by improving the thermal conductivity of the mass, which normally is low.

A number of runs were made with added sand, using two different ratios of cyanide to sulphonate and varying proportions of sand. The results are given in Fig. 7. The addition of sand to the mixture at first caused an increase in the benzonitrile yield, as was predicted. The yield, however, attained a maximum with the addi-

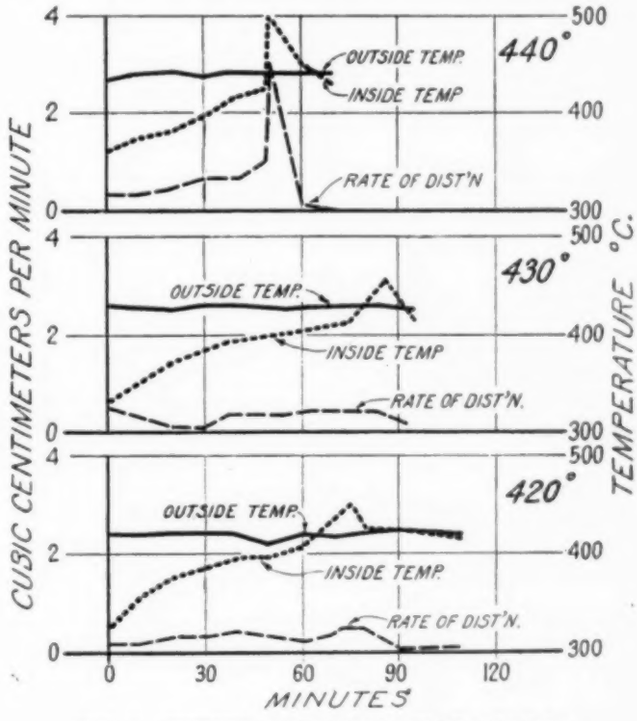


FIG. 6. EFFECT OF TEMPERATURE CHANGE

tion of about 70 per cent sand. These results indicate that the course of the reaction is influenced by several factors. In the first place, the sand dilutes the reaction mixture and lowers the undesired temperature rise, thereby increasing the yield. On the other hand, by dispersing the particles of the reacting materials, the

[76] Molecular heats of formation at 20 deg.:

$NaSO_3C_6H_5$ (solid)	+192.3 cal.	Berthelot, *Ann. Chim. Phys.*, (5), vol. 9, p. 301 (1876); *Thermochimie* (1897), II, p. 418.
Na_2SO_3 (solid)	+261.4	de Foerand, *Ann. Chim. Phys.* (6), vol. 3, p. 242 (1884); Berthelot, *Thermochimie*, II. p. 206.
NaCN (solid)	+22.6	Berthelot, *Thermochimie*, II, p. 213; Landholt and Bornstein, Tabellen, 1912, p. 841.
C_6H_5CN (liquid)	—33.1	Berthelot and Pettersen, *Ann. Chim. Phys.* (6), vol. 18, p. 117 (1889).
Molecular heat of evaporation:		
C_6H_5CN	—9.0 cal.	Kahlenberg, *J. Phys. Chem.*, vol. 5, p. 215 284 (1901); Landholt *op. cit.*, p. 841.

[77] Morgan, "Elements of Physical Chemistry," 5th Edition (1914), p. 222.

[78] U. S. Pat. 1,367,898.

sand renders contact between them less intimate and thus decreases the yield. The surface of the diluent probably has an influence as well; the benzonitrile vapor on coming in contact with the heated surfaces of the sand particles undergoes pyrogenic decomposition.

With proportions of sand up to 70 per cent the increase in yield due to dilution overbalances the

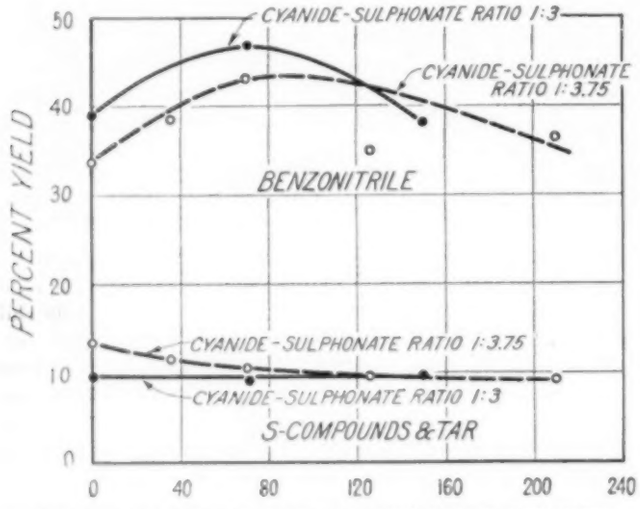


FIG. 7. EFFECT OF ADDITION OF SAND

unfavorable effects of the increase in surface and volume. Above this point, however, these unfavorable characteristics more than offset the beneficial influence of additional dilution, and the yield decreases.

Effect of Reduced Pressure

A run was made in which the pressure within the retort was maintained at 120 (±5) mm. mercury, absolute pressure, by means of a suction pump. The reduction in pressure was found to make no change in the minimum temperature of the reaction. The results are given in Table III. A run at atmospheric pressure is included for comparison.

These results indicate that lowering the pressure favors the formation of sulphur compounds and tar at the expense of benzonitrile. As the formation of sulphur compounds is accompanied by the simultaneous liberation of large quantities of gaseous products, this result is in accord with Le Chatelier's theorem, the reaction taking place with the greatest increase in volume being favored by reducing the pressure. Hence the use of reduced pressure is undesirable.

In summing up the above results, it may be stated that the most favorable conditions for the benzonitrile reaction have been shown to be: Temperature 420 to 430 deg.; atmospheric pressure; cyanide and sulphonate in equimolecular proportions, or a slight excess of cyanide; the addition of a certain amount of inert material. For 40-mesh sand, the optimum quantity for addition is 70 per cent, for other inert materials the amount to be added would probably differ.

The Use of Low-Grade Commercial Cyanides

A number of processes which utilize atmospheric nitrogen in the manufacture of alkali cyanides have been developed. At least two of them are now being operated on a commercial scale. Since these processes are possible sources of cheap cyanide, it was thought advisable to determine the applicability of such material to the benzonitrile reaction.

Cyanide prepared from calcium cyanamide by heating with salt and carbon is being manufactured in large quantities and has proved a satisfactory substitute for the purer material for many purposes.[79] Such "sodium cyanide" is relatively impure, containing 25 to 60 per cent NaCN equivalent, the remainder consisting of other sodium salts, calcium salts, carbon, etc.

TABLE III. EFFECT OF PRESSURE

Ratio NaCN : $NaSO_3C_6H_5$: : 1 : 3.00 by weight; temperature 430 deg.

	Absolute Pressure mm. Mercury	
	760	120
Benzonitrile	39.0%	37.5%
S compounds and tar	9.7%	14.6%

Yield based on sodium benzene sulphonate

A sample of this cyanide was obtained which was stated by the makers to have approximately the following composition: NaCN 30 per cent, NaCl 4 per cent, $CaCl_2$ 35 per cent, CaO 13 per cent, remainder carbon and undetermined. The material was in the form of gray, flaky fragments.

A mixture of this material and sodium benzene sulphonate, in the ratio NaCN: $NaSO_2C_6H_5$ of 1:3, was distilled in the usual manner. A yield of only 11.7 per cent benzonitrile (based on $NaSO_2C_6H_5$) was obtained. Apparently the cyanide in this material is in a form not readily available for the reaction, or perhaps the impurities present, especially the large amount of free

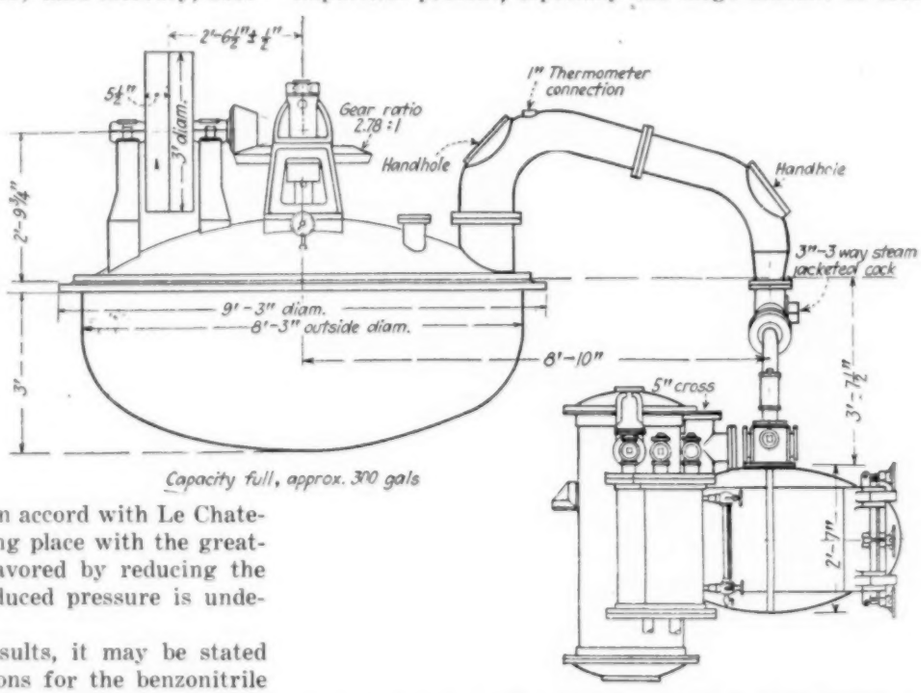


FIG. 8. STILL IN USE IN LARGE-SCALE EXPERIMENTS

lime, affect the yield unfavorably. As already stated, the addition of a small amount of sodium hydroxide

[79] Landis, *Trans.*, Am. Electrochem. Soc., vol. 37, p. 87 (1920).

caused a large decrease in yield. Calcium oxide might well have the same effect. According to Landis, the cyanide is present as the calcium salt rather than as sodium cyanide.

Experiments on a Commercial Scale

During the course of this work the apparatus shown in Fig. 8 became available for large-scale experiments. It consisted essentially of a beta-naphthol still of the usual type (capacity about 300 gal.) modified by the addition of a stirrer with two scraper arms set close to the bottom of the still. The still was set in brickwork and heated by a coke fire. A pyrometer was fixed in the hollow shaft of the stirrer. Reduced pressure could be maintained if desired. Although this equipment was clearly not well adapted to carrying out the reaction, it was thought that some information might be obtained by its use.

Commercial 96 to 98 per cent sodium cyanide and high-grade sodium benzene sulphonate specially dried were used. No machinery was available for grinding and mixing the components of the charge, so it was necessary to use the coarse materials and trust to the mixing action of the stirrer in the still.

In one run a mixture of several hundred pounds of cyanide and sulphonate in equimolecular proportions were charged into the still and the temperature raised. Temperature control was difficult, and the indications of the pyrometer were of little value. When the reaction began it was propagated through the mass with great violence. The gases evolved were not able to escape through the offtake pipe and receiver fast enough, and the pressure within the still rose, finally blowing out the packing between the cover and the body of the still and allowing large quantities of gases to escape. The distillate which collected in the receiver consisted mainly of sulphur compounds, as might be expected from the high reaction temperature.

In other runs attempts were made to feed the reaction mixture into the hot still in small quantities. Runs were also made in which one of the components was placed in the still and the other added gradually. These experiments were unsuccessful, partly because of mechanical difficulties, and partly, no doubt, because intimate mixing could not be secured. This work was carried out before the favorable effect of dilution had been demonstrated in the laboratory. No large-scale experiments using diluents were made.

This work showed conclusively that apparatus of the type used is absolutely unadapted to carrying out the reaction on a large scale. For successful operation, intimate mixing, accurate temperature control and means for dissipating the heat of the reaction are necessary.

Hydrolysis of Benzonitrile

Many workers have investigated the hydrolysis of nitriles in the past. Both acid and alkaline solutions have been employed. Although physicochemical studies[50] of the reaction velocities indicate that, in the cold, hydrolysis by dilute alkalis is more rapid than by dilute acids, it has generally been found that warm moderately concentrated acids give more rapid and more complete hydrolysis than aqueous alkaline solutions.[51]

From a commercial standpoint the use of acid seems the more advantageous. If, for instance, sulphuric acid is used, the products of the reaction are free benzoic acid, and ammonium sulphate, which remains in solution. The benzoic acid may be recovered by steam distillate, while the acid ammonium sulphate solution may be circulated through a scrubber to absorb the ammonia in the gases from the benzonitrile still, after which the ammonium sulphate content may readily be recovered. If caustic soda solution is used as the hydrolytic agent, an absorption system must be employed to recover the ammonia evolved. Moreover, the resulting sodium benzoate solution contains an excess of alkali and other impurities, which prevent its direct evaporation for the production of sodium benzoate. Hence it must be acidified to precipitate out benzoic acid, thereby necessitating a considerable expenditure of acid and alkali.

Experimental Work on Hydrolysis

It was found that benzonitrile could be hydrolyzed smoothly and rapidly by heating with 2.5 to 4 times its volume of sulphuric acid, sp.gr. 1.60 to 1.66 (54 to 59 deg. Bé.; 68 to 74 per cent H_2SO_4). In fact, the reaction when once started proceeded spontaneously from its own heat. It was necessary to add the benzonitrile to the hot acid gradually when large amounts were hydrolyzed.

In order to determine the efficiency of this method of hydrolysis, a weighed sample (2 g.) of re-distilled benzonitrile (b.p. 190 to 191 deg.) was heated with 20 c.c. sulphuric acid (sp.gr. 1.6) in a flask with reflux condenser for thirty minutes. The flask was cooled, contents diluted, and extracted with four 10 c.c. portions of ether. The ether extract was washed with several small portions of water to remove traces of sulphuric acid, transferred to a tared flask, the ether distilled off, and the residue weighed. A weighed portion of the residue was then titrated with fifth-normal sodium hydroxide previously standardized against Bureau of Standards benzoic acid.[52] A yield of 95.2 per cent of theory was obtained. It is probable that the actual conversion of benzonitrile into benzoic acid was nearly quantitative, and that the deficiency of 4.8 per cent was due mainly to losses inherent in the method of analysis, loss by incomplete extraction, by washing the ethereal solution with water and by volatilization of benzoic acid on distilling off the ether.

A sample of the crude benzonitrile as obtained by steam distillation was next analyzed in the same manner. A benzoic acid yield equivalent to 90.4 per cent of theory was obtained. Assuming again a loss of 4.8 per cent in analysis, the crude benzonitrile contained 94.7 per cent C_6H_5CN, a figure which confirms the results of fractional distillation.

These results indicate that hydrolysis by sulphuric acid is a rapid and efficient method of converting benzonitrile into benzoic acid. On a large scale the losses ought to be small, and a conversion efficiency of around 95 per cent ought to be readily obtainable.

A larger quantity of crude benzonitrile was next hydrolyzed in order to determine the purity of the resulting acid. The benzonitrile was allowed to flow drop by drop into 2.5 times its volume of hot sulphuric acid, sp.gr. 1.6 (54 deg. Bé.), contained in a flask provided with a reflux condenser and a stirrer. Flask and contents were maintained at 125 to 140 deg. during

[50] von Peskoff and Meyer, *Zeit. phys. Chem.*, vol. 82, p. 129 (1913).

[51] For a summary of methods of hydrolysis see Sudborough, *J. Chem. Soc.*, vol. 67, p. 601 (1895).

[52] Morey, *Bull. Bur. Standards*, vol. 8, p. 643 (1913).

the addition of the nitrile and for thirty minutes thereafter. The contents were then subjected to steam distillation, and the beautifully crystalline benzoic acid filtered out of the cooled distillate.

A sample of this acid dried over concentrated sulphuric acid had a slight odor, a faint yellowish tinge, m.p. 121 deg. Its C_6H_5COOH content by titration was 99.67 per cent. A 2-g. sample was burned in a calorimeter bomb in the usual manner. The bomb washings showed only a faint opalescence with barium chloride, indicating that the acid was practically sulphur free. It was, of course, free from chlorine. By subliming this acid, or by dissolving it in alkali, re-precipitating and re-crystallizing from water, pure white samples, practically odorless, were prepared.

Discussion of Results

Some estimate can now be made of the commercial possibilities of the proposed process. The table gives the cost of the principal raw materials per hundred pounds of benzoic acid for the commonly used benzyl chloride-bleach process and for the nitrile process. Comparison is made with the bleach process because this is the one at present in most common use. The prices of all materials except sodium benzene sulphonate are those current May 1, 1920. Sodium benzene sulphonate is not ordinarily quoted in the market reports, but sales are known to have been made at this date at the figure given. Present prices for delivery on contracts would be lower for every item.

RAW MATERIAL COST PER 100 LB. BENZOIC ACID

Benzyl chloride-bleach process:	
143 lb. toluene at 4c.	$5.72
143 lb. chlorine at 6c.	8.58
1 149 lb. bleaching powder at 4c.	45.60
Cost per 100 lb. benzoic acid	$59.90
Proposed nitrile process:	
380 lb. sodium benzene sulphonate at 7c.	26.60
104 lb. sodium cyanide (96-98%) at 24c.	24.96
Cost per 100 lb. benzoic acid	$51.56

The quantities assumed for the benzyl chloride-bleach process are those actually employed in large-scale manufacture. Calculations for the nitrile process are based on a nitrile formation efficiency of 43 per cent and 90 per cent efficiency on hydrolysis. The cost of the acid required for hydrolysis has not been included, and no credit has been allowed for the ammonium sulphate formed as a byproduct. Assuming 70 per cent recovery of the nitrogen content of the cyanide used, a conservative figure, about 1 lb. of ammonium sulphate would be recovered for every pound of benzoic acid produced. At the present quoted price of ammonium sulphate this would far more than pay for the acid required.

These figures, of course, do not take into consideration manufacturing costs. In the case of the nitrile process no data are available on which to base an estimate. There is no reason to believe, however, that manufacturing costs of the two processes would differ greatly.

The nitrile process might perhaps labor under a certain handicap because of the highly poisonous nature of the cyanide used. Accidents in the other industries employing cyanide are infrequent, and with proper precautions accidents ought not be feared. A distinct advantage of the process would be the purity of the product, as benzoic acid free from chlorine commands a premium of 10c. a pound over the ordinary acid.

It is, however, in connection with the future of the cyanide industry that the proposed process appears most interesting. The problem of cheap cyanide has been attacked with great vigor in recent years, and with striking success. The price of sodium cyanide has been declining steadily for some time, and increases in production and improvements in methods of manufacture will probably cause a further drop. As production has increased, new uses for cyanide have been sought. Its use in the manufacture of organic chemicals has been proposed, but up to the present no appreciable amount has been employed in this branch of the industry. The proposed process, however, might well offer a profitable means of utilizing some of the surplus cheap cyanide produced by improved methods.

Summary

A process for the manufacture of benzoic acid from benzene has been outlined and studied in detail. The mechanism of the reaction and the nature and extent of the side reactions have been investigated. The effect of variations has been studied and the optimum conditions for the reaction have been established.

The results of the experimental work indicate that, with a source of cheap cyanide, the process proposed would produce benzoic acid of a higher degree of purity than the bulk of the acid on the market today at a cost below that of the present methods of manufacture.

Department of Chemical Engineering,
Columbia University,
New York City.

Record Production of Borax in 1920

The quantity of borax produced and sold in the United States in 1920 was 35,280 short tons, valued at $5,674,000, according to R. C. Wells, of the United States Geological Survey. This is a record production and value, exceeding even those of 1919—28,518 tons and $4,351,891—which were higher than those of any previous year.

For many years borax has been manufactured in the United States from the mineral colemanite, a calcium borate, which is mined in California, but for the last two years some borax has also been obtained from the water of Searles Lake, California, as it is one of the salts that the brine yields by a certain method of treatment. This method of treatment marks a new departure in the borax industry and recalls the old days in the '60s when borax was made by recrystallizing the crude salt found in the mud of Borax Lake.

The total quantity of crude borates produced in the United States in 1920 amounted to 120,320 tons, valued at $2,173,000. This is a record in quantity, though not in value, on account of the lower grade of the ores.

Borax is used in large quantities in making the enameled coating for cast-iron and steel ware used in plumbing fixtures, chemical equipment and kitchen utensils. It is also a constituent of borosilicate glasses, such as are employed in making lamp chimneys, baking dishes and laboratory glassware. Considerable borax is also used in the laundry and kitchen, in making soap and starch, in paper sizing, and in tanning and welding.

In the United States a considerable quantity of boric acid is made from borax as well as from colemanite. Boric acid is an antiseptic and is also used in cosmetics. It is also employed to preserve meats under conditions permitted by the food and drugs act.

Microstructure of Chromium Steels

Brief Review of the Literature, Especially From the Japanese Investigator Murakami, Presenting a Structural Diagram, Micrographs and an Explanation of the Changes in Transformation Temperature Following Various Reheatings

IN AN early investigation of the effect of chromium in steels Osmond[1] concluded that this element might exist in a state of solid solution in iron, as a compound of chromium, iron and carbon, or as a solid solution of the compound in iron. From his microscopic examination of two series of chromium steels Guillet[2] reported three types of structure—i. e., pearlitic, martensitic or troostitic, and double carbidic, these differences being known to depend upon the thermal treatment. Double carbides of chromium and carbon have been reported by other investigators, though no formulæ have been agreed upon. By heating metallic chromium and carbon in an electric furnace Moissan[3] obtained two carbides, Cr_3C_2 and Cr_4C.

Likewise Williams[4] obtained a double carbide, $3Fe_3C.2Cr_3C_2$ by using a mixture of chromium oxide, iron and petroleum coke. Carnot and Goutal[5] obtained chemically the residues $Fe_3C.3Cr_3C_2$ from a ferrochromium and $3Fe_3C.Cr_3C$ from two chromium steels. Arnold and Read[6] also carried out an extensive investigation of iron: carbon: chromium alloys and by analyzing the residues obtained by electrolysis (experimenting upon well-annealed samples containing 0.64 to 0.85 per cent carbon and 0.65 to about 24 per cent chromium) concluded that in steels containing less than 10 per cent chromium this element exists as carbides Cr_3C_2 or Cr_4C and forms an isomorphous mixture with cementite and that in steels containing 15 to about 24 per cent a double carbide $2Fe_3C.3Cr_4C$ exists. In respect to this latter conclusion, however, their experimental methods have been questioned and severely criticised.

The self-hardening property of certain chromium steels—as evidenced by the lowering of the Ar_1 transformation with increase in initial temperature—has also long been recognized. Osmond[1] noticed this effect and also reported the tendency of a high percentage of chromium to raise Ar_1. Carpenter, however, who likewise observed this latter effect, concluded that chromium cannot be regarded as an element which imparts a self-hardening property to steels, because by raising the temperature of occurrence of Ar_1 it hastens the carbide transformation. On the other hand, Edwards and Kikkawa[7] in studying high-speed tool steels more recently demonstrated that within certain limits of composition chromium has an even greater self-hardening effect than tungsten, and further that the cooling rate plays an important part in producing this property. Using steel containing 0.63 per cent carbon and 6.1 per cent chromium, the critical cooling velocity which produces self-hardening was determined. Its variation with initial temperature was observed, being lower as this temperature is higher. These authors also proposed a theory concerning the dissociation of the carbide, considered to be Cr_3C_2. According to their view, the carbide first goes into solution as $(Cr_3C_2)_3$ at the Ac_1 point and then gradually dissociates into Cr_3C_2 as the temperature

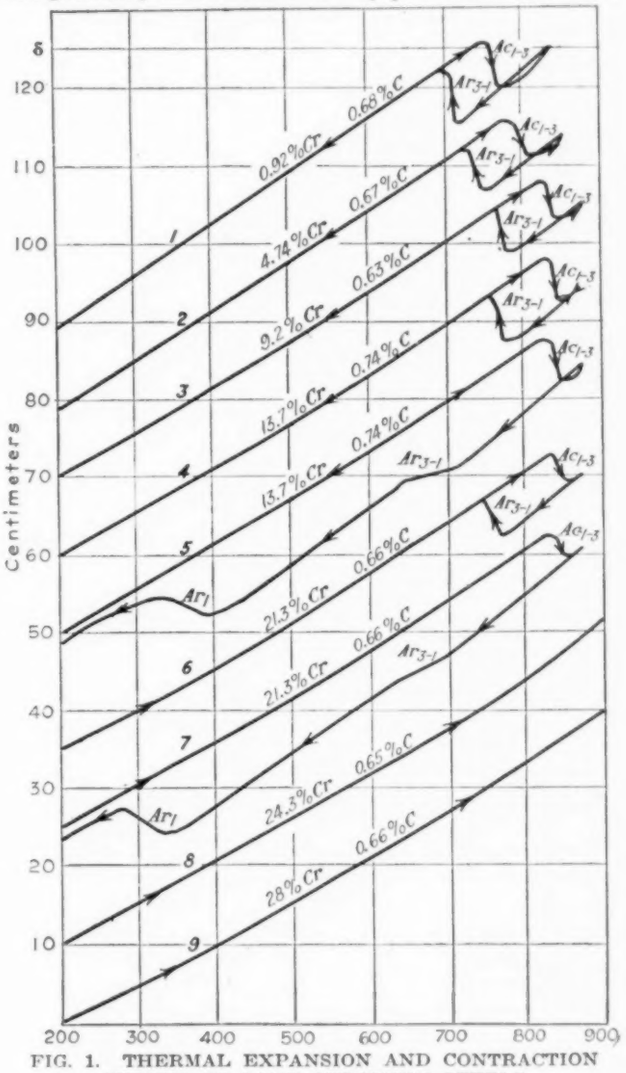


FIG. 1. THERMAL EXPANSION AND CONTRACTION CURVES OF SOME CHROMIUM STEELS

is raised, the carbide point being more readily lowered by this increase of the number of molecules in solution.

A Japanese paper comparing previous investigations and based on a study of the constitution of chromium steels[8] containing less than 4 per cent carbon and 0.5 to about 90 per cent chromium was published in April, 1918, by Murakami. The effects of carbon and chromium and various thermal treatments on the A_2 transformation were studied by magnetic analysis, using a magnetometer and torsion balance described briefly in

[1] *J. Iron & Steel Inst.*, 1892, No. 2, p. 115.
[2] *Rev. Met.*, 1904, p. 155.
[3] *Elect. Furnace*, 1904, p. 144.
[4] *Compt. rend.*, vol. 127 (1898), p. 410.
[5] *Compt. rend.*, vol. 126 (1898), p. 1,243.
[6] *J. Iron & Steel Inst.*, 1911, No. 1, p. 249.
[7] *J. Iron & Steel Inst.*, 1915, No. 2, p. 6.

[8] "On the Structure of Iron-Carbon-Chromium Alloys," T. Murakami, *Sci. Reports*, Tohōku University, vol. 7, No. 3, p. 217.

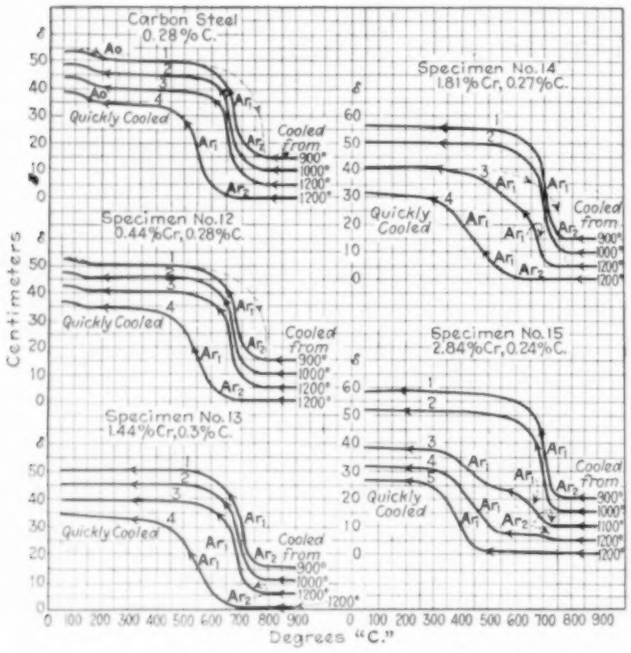


FIG. 2. MAGNETIZATION-TEMPERATURE CURVES OF SOME CHROMIUM STEELS

CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 573, March 30, 1921. The latter apparatus was used for alloys worked with difficulty or not at all. Thermal-expansion measurements, as illustrated in Fig. 1, were used to study more closely effects of such variables on the A_1, $_2$ transformations, while these tests were supplemented by and correlated with thermal analysis and microscopic examination. Typical magnetization-temperature curves are shown in Fig. 2.

The results of this investigation may be summarized as follows:

MAGNETIC ANALYSIS

1. Magnetic analysis shows that in steels containing relatively high carbon and low chromium the Ar_1 transformation occurs at about 700 deg. C. Increase in chromium content raises its position, a result which agrees with the work reported by earlier investigators. Similarly in low-chromium steels the magnetic transformation of cementite A_0 and that of the double carbide occurring at 150 deg. C. are found, the former disappearing before the latter as the proportion of chromium increases.

2. Certain chromium steels containing a relatively high proportion of chromium to carbon are self-hardening. The amount of lowering of the transformations increases with maximum temperature, increase of carbon or of chromium, the other element remaining constant. In steels of high chromium and low carbon the A_2 transformation is the only one found, decreasing as chromium increases.

3. The rate of cooling has a marked effect on the transformations. In steels for which the lowering does not take place by normal cooling it may be obtained by faster rates, and the transformation which is lowered by normal cooling is further suppressed by rapid cooling. Sufficiently slow cooling, however, throughout a range about 700 deg. C. will allow it to take place completely.

CONSTITUTION

After annealing at about 900 deg. C., and slowly cooling through the range about 700 deg. C., the iron: carbon: chromium alloys may be divided into five classes having characteristics as noted. Parentheses indicate constitutents present in a free state.

I. Alloys having three transformations at about 700, 210 and 150 deg. C. consist of (Fe) + (Fe_3C) and (α) double carbide.

II. Alloys having two transformations at about 700 and 150 deg. C. consist of (Fe) + (α) and (β) double carbides.

III. Alloys having a single transformation at about 700 deg. C. consist of (Fe) + (β) and (γ) double carbides.

IV. Alloys having the lowered Ar_1 transformation. Present in both regions IV and V of Fig. 3, region IV representing alloys consisting of (Fe) + (γ + Cr_4C).

V. Alloys having only the A_2 transformation. Consist of (Fe + Cr) + (Cr_4C + Cr). These steels show lowering on normal slow cooling provided the proportion of chromium to carbon is relatively low. They are martensitic. Very slow cooling through the range about 700 deg. C., however, sets the dissolved carbide free.

Murakami points out the fact that the only two regions where lowering occurs on normal cooling (IV and V) are those containing the carbide Cr_4C and concludes therefore that the lowering is related to this constituent and further proposes the following hypothesis: When alloys containing Cr_4C are heated to above the A_1 transformation the carbide changes thus:

$$2Cr_4C \rightleftharpoons Cr_3C_2 + 5Cr$$

The higher the temperature the further the reaction proceeds from left to right. During cooling Cr_3C_2 and chromium only slowly associate and by the retarding action of the latter the carbide change is lowered even in normal cooling.

Lowering of the transformations also occurs on rapid cooling from 1,200 deg. C. in alloys of region III, Fig.

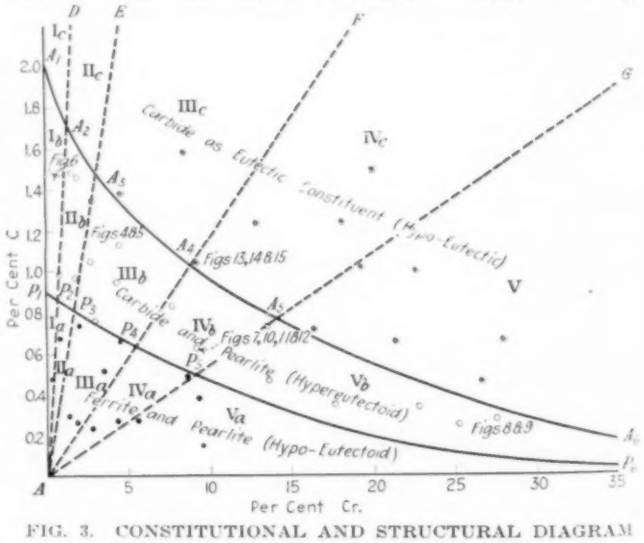


FIG. 3. CONSTITUTIONAL AND STRUCTURAL DIAGRAM FOR IRON: CARBON: CHROMIUM ALLOYS

3, which is similarly explained by previous dissociation of the double carbide, producing Cr_4C. The formulæ proposed for the α, β, and γ double carbides and dissociation of the last two are given below:

α double carbide $(Fe_3C)_{10}.Cr_4C$ (6.01 per cent Cr, 87.40 per cent Fe, 6.59 per cent C).

β double carbide $(Fe_3C)_9.Cr_4C$ (11.30 per cent Cr, 82.18 per cent Fe, 6.52 per cent C).

Dissociation $2(Fe_3C)_9.Cr_4C = (Fe_3C)_{18}Cr_4C + Cr_4C$.

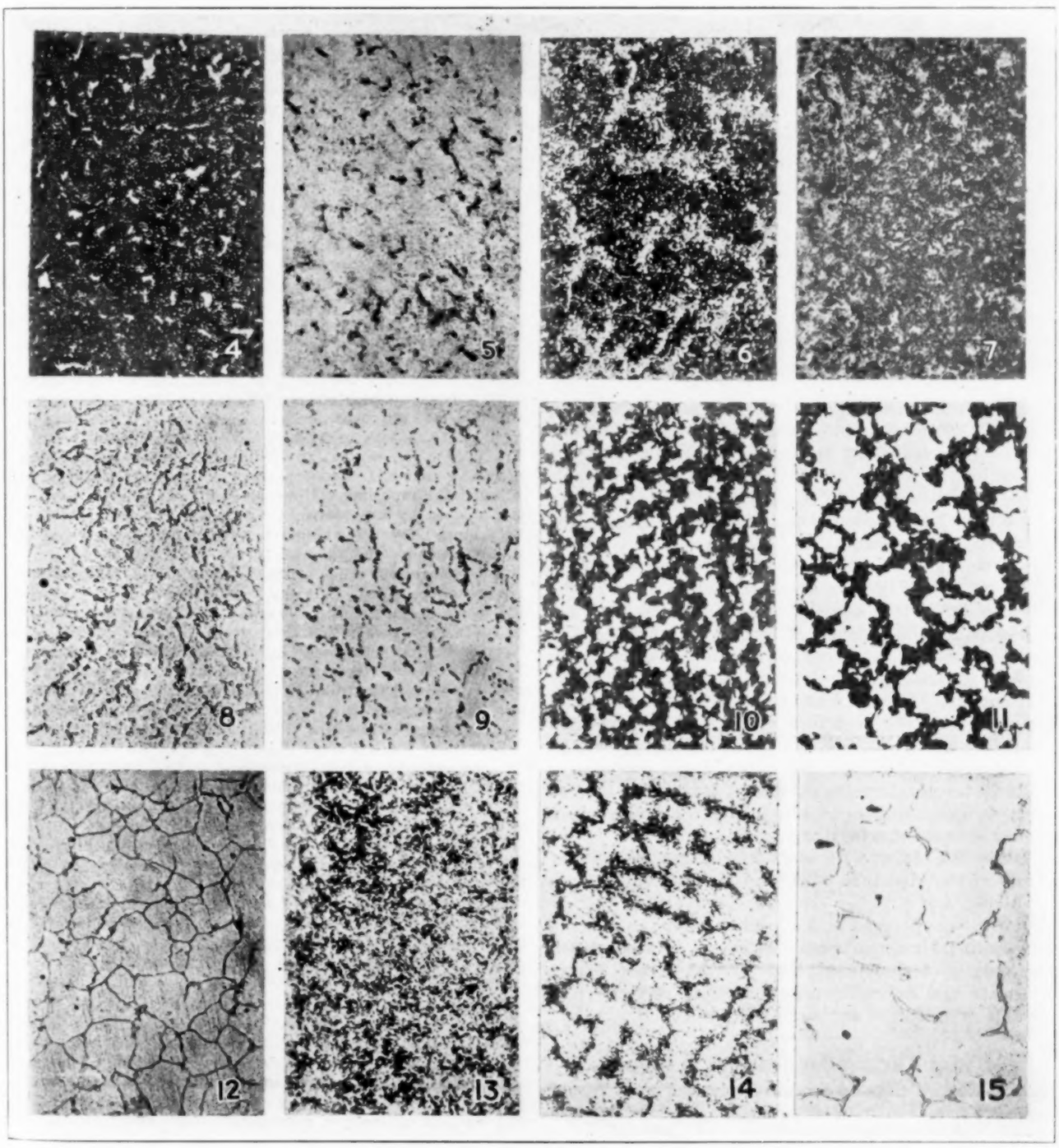
γ double carbide $Fe_3C.Cr_4C$ (52 per cent Cr, 42 per cent Fe, 6 per cent C).

Dissociation $9Fe_3C.Cr_4C = (Fe_3C)_9.Cr_4C + 8Cr_4C$.

On normal cooling these products of dissociation recombine, but in rapid cooling the components have not sufficient time to associate and lowering is produced.

Thus the self-hardening of a chromium steel is related to the lowering or complete suppression of the Ar_1 transformation, the hardness being caused by the solid solution of Cr_3C_2 in iron which has already dissolved chromium. Steels having the normal transformation point show troostitic or pearlitic structures, while those having the lowered transformation are martensitic. Where this transformation is completely suppressed the steels are austenitic.

Fig. 3 shows the locations where normal structures of



FIGS. 4 TO 15. MICROGRAPHS OF SOME CHROMIUM STEELS. × 120.* ALL ETCHED WITH ALCOHOLIC PICRIC OR NITRIC ACID EXCEPT AS NOTED

Fig.	Analysis	Heat Treatment
4	4.63 Cr, 1.13 C	Slowly cooled from 900°
5	4.63 Cr, 1.13 C	Slowly cooled from 900°
6	1.12 Cr, 1.49 C	Slowly cooled from 900°
7	9.2 Cr, 0.63 C	Slowly cooled from 900°
8	27.5 Cr, 0.28 C	Slowly cooled from 900°
9†	27.5 Cr, 0.28 C	Slowly cooled from 900°

Fig.	Analysis	Heat Treatment
10	9.2 Cr, 0.63 C	Cooled from 1000°
11	9.2 Cr, 0.63 C	Cooled from 1100°
12	9.2 Cr, 0.63 C	Cooled from 1200°
13	9.33 Cr, 1.09 C	Slowly cooled from 900°
14	9.33 Cr, 1.09 C	Quickly cooled from 900°
15	9.33 Cr, 1.09 C	Quickly cooled from 1200°

†Etched with $K_3Fe(CN)_6$.

the forgeable alloys may be expected. Steels showing ferrite and pearlite are represented by a dot, those having the carbide primarily separated from austenite and pearlite by a circle and those having the carbide separated from the melt as a eutectic constituent by a dot inside a circle. Typical micrographs are shown in Figs. 4 to 15, inclusive.

Except as otherwise specified, alcoholic solutions of picric or nitric acids were used for etching alloys low in chromium, and an aqueous solution of hydrochloric acid for high-chromium steels. The double carbides of chromium and iron, except the α carbide, are not colored by sodium picrate solution, either hot or cold. An etching reagent consisting of 10 g. of potassium ferricyanide and 10 g. of potassium hydroxide dissolved in 100 c.c. water colors the γ double carbide brown in ten to twenty seconds, and turns it blue to yellow on longer immersion. The β double carbide is hardly colored by this reagent at room temperature, but is readily colored brown to blue when the solution is boiling. The α double carbide and cementite are colored brown in the boiling solution, but the color is less intense than that obtained by use of sodium picrate. The carbide Cr_4C is hardly attacked by either hot or cold solution while the solid solution of iron and chromium is colored brown to blue.

Figs. 4 and 5 show typical structure of region III_b of Fig. 3, containing a quantity of γ double carbide which is not colored by the cold ferricyanide solution, acids or boiling sodium picrate. Cementite and α double carbide are shown in Fig. 6, it being possible to color the globules by boiling sodium picrate but not by the cold ferricyanide reagent.

γ double carbide dissolving some Cr_4C is shown in Fig. 7, while in Fig. 8 is shown a ground mass of the solid solution of iron and chromium and a chain of fine globules of a solid solution of Cr_4C in chromium. The coloration obtained in cold ferricyanide is shown in Fig. 9. This latter alloy belongs in region V_b of Fig. 3.

Figures 10, 11 and 12 show the effect of maximum temperature on the structure of the steel represented in normal condition in Fig. 7. White patches in Fig. 14 are martensite; dark are troostite. With increase in maximum temperature the patches of martensite become larger, as shown in Fig. 11, and in Fig. 12 the structure becomes entirely martensitic.

Figures 13, 14 and 15 show the effect of rate of cooling on the structure of a steel containing 1.09 per cent carbon and 9.33 per cent chromium. Slow cooling from 900 deg. C. results in pearlite (Fig. 13), while rapid cooling gives martensite, as shown in Fig. 14. On slow cooling from 1,200 deg. C. this steel shows martensite and troostite, while on rapid cooling from the same temperature austenite is retained (Fig. 15).

Hydro-Electric Development in Italy

Hydro-electric development in Italy has made rapid progress during the last few years. It is estimated that whereas in 1915 Italy's electric power resources amounted to 2,500,000,000 kw.-hr. per annum, this figure had been increased to 3,700,000,000 before the end of the war, and now approximates 4,000,000,000. Whereas in 1915 the capital of Italian electric companies was less than 600,000,000 lire, it now reaches about 1,500,000,000 lire. During the five years from 1915 to 1920 there were completed new hydro-electric plants yielding 265,000 hp., and plants now under construction will yield 400,000 hp. additional.

Synopsis of Recent Chemical & Metallurgical Literature

Present Status of the Synthesis of Ammonia by the Hyper-Pressure Method.—At the Feb. 21, 1921, meeting of the French Academy of Sciences, Georges Claude presented a note on the present status of the synthesis of ammonia by the hyper-pressure method. The first practical demonstration of the process before a number of members of the Academy took place Jan. 9, 1920, when the mixture $N_2 + 3H_2$ was first compressed to 100 atm. by an ordinary compressor of 60 cu.m. per hour capacity and then compressed by two hyper-compressors in series to 300 and 1,000 atm. The hyper-compressed mixture after it had been purified was passed through a catalyzer tube giving from 6 to 7 liters of liquid ammonia per hour. All the apparatus had to be placed in wells and the manipulations were difficult.

The second demonstration took place Nov. 20, 1920. At this time there were four catalyzing tubes instead of one. The tubes were arranged two in parallel and the other two in series and sufficient for the combination of 80 per cent of the gases treated. The tubes were placed in separate compartments located in a building on the ground. The same hyper-compressors were used as during the first demonstration, but were operated to produce 150 cu.m. per hour instead of 60. All the installation proved to be perfectly gas tight, as there was no trace of ammonia odor in the building. The production was 60 to 70 liters of liquid ammonia per hour—i.e., about 1.25 tons per day. This installation is still running for experimental purposes only. The hydrogen used is produced by an electrolytic cell and this makes its cost very high. Extensive research work is now going on to obtain cheaper hydrogen.

At the present time a great step in the process has already been realized—namely, the production by a single hyper-compressor of the two stages 100 to 300 atm. and 300 to 900 atm., which is the final pressure used. This hyper-compressor has been made by M. Le Rouge and compresses 700 cu.m. of the mixture per hour, a quantity sufficient to give 5 tons of anhydrous ammonia per day, equivalent to 25 tons of ammonium sulphate per day. The energy consumed for the compression of 710 cu.m. from 1 to 100 atm. was 187 hp. and for the compression from 100 to 900 atm. 122 hp.—i.e., about ½ hp.-hr. is required to compress 1 cu.m. of the mixture to 900 atm. The tightness of the installation is such that under the hardest conditions of starting and stopping of the operations the loss of gas mixture was less than 0.5 per cent. One of the four catalyzing tubes of a capacity of 5 tons NH_3 per day was tested at the same time and found to work successfully.

Since former tests showed that it is easy to have all four tubes working simultaneously, the application of the process to large industrial units seems certain to prove successful, provided an adequate cheap source of hydrogen can be found.

Use of Belting in Fertilizer Plants.—The severe service to which belts are subjected in fertilizer factories makes their selection and care a matter of more importance than in most manufacturing establishments. Acid fumes and gritty dust are both found in varying quantities in every fertilizer plant, and both are enemies of belt efficiency. The introduction of electric motors in a number of the larger plants has reduced the amount of belting required, but there is no indication that any plant will ever be able to dispense altogether with belts.

Results of a study of the use of belting in this industry have been published in *American Fertilizer*, March 12, 1921, p. 57. Replies to a questionnaire were received from manufacturers having an annual output of a little over 3,000,000 tons, somewhat less than one-half of the total production.

Power transmission belting. An analysis of the data received indicates that the fertilizer industry in the United

States uses approximately 765,000 linear ft. of power belting, of which 85 per cent is rubber, 9½ per cent leather, and 5½ per cent fabric. The favor with which rubber belting is held in fertilizer factories is due primarily to its acid-resisting qualities. The fumes from the acidulating room and the acid reaction from the acid phosphate dust both affect largely the life of the belts. As long as the rubber coating on a belt completely protects the enclosed fabric the belt stands up well against acid vapors.

The first cost of a rubber belt is less, which is an additional argument in its favor. This was especially true when the war-time demand for leather reduced the supply available for belts. As a general rule leather belting is used on heavy drives which can be separated from the unfavorable factory conditions. This is often the case with the belt transmitting from the primary source of power. There is some leather belting in use which has been impregnated with an acid-resisting substance.

Dust is second only to fumes as a source of belt trouble in fertilizer factories. It increases the wear on the belt, and thus shortens the time, in the case of rubber belting, when the protective covering is worn through and the underlying fabric exposed. As soon as this occurs the deterioration of the belt is rapid. Dust also increases the slipping, which is an inherent weakness in rubber belting. This excessive slipping must be counteracted by running the belt tighter or by using a belt dressing. Both of these remedies are costly in the end. One company estimates that fumes and dust in its factory reduce the life of its belting by one-half.

Where care is taken to keep down dust, the increase in the life of the belt is noticeable. Some companies report that they have obtained nine and ten years of continuous service from favorably located rubber belts. As a general rule the unfavorable conditions in fertilizer factories more than counterbalance the natural superiority of leather belting for the transmission of power. Experience has demonstrated that rubber is better adapted for most of the work.

Conveyor belts. The conveyor belts in fertilizer factories vary in width from 12 to 30 in. From the figures received it is estimated that the industry uses about 28,000 linear ft. of conveyor belting, 89.9 per cent of which is rubber, and 10.1 per cent fabric. About 40 per cent of the manufacturers use conveyor belts.

The same conditions which affect the power belting cause deterioration in conveyor belting. A certain density of surface is necessary in conveyor belts to prevent the gritty material from working into the body of the belt.

Where the design of the building and the location of the machinery permits the use of bucket elevators and other devices for conveying materials, these are preferred to belt conveyors by a number of the manufacturers.

Test Code for Evaporating Apparatus.—In 1918 the Power Test Committee of the American Society of Mechanical Engineers was reorganized to revise and enlarge the power test codes of the society published in 1915. The committee is a large one, under the chairmanship of Fred R. Low, and under its direction are nineteen individual committees of specialists which are drafting codes for the different classes of apparatus comprised in power plant equipment. The third of these codes, the test code for evaporating apparatus, was published in *Mechanical Engineering*, vol. 43, p. 184, March, 1921. This code is intended primarily for apparatus heated by steam, such as vacuum pans or single- and multiple-effect evaporators.

Trade Notes on Bauxite.—In order to encourage the development of mineral resources, the Geological Survey of India has prepared a series of papers on the more important minerals. One dealing with bauxite, by J. Coggin Brown, has been published in the *Journal of Indian Industries & Labour*, vol. 1, part 1, p. 54, February, 1921. After discussing distribution of Indian deposits, uses, grades, specifications, other sources of supply and statistics, the question of the best method of developing the deposits is taken up. Since the present consumption of aluminum in India is comparatively small, manufacture of the metal on an economical scale would involve building up an export business. An alternative would be the manufacture of pure alumina locally for export to aluminum works or for the local manufacture of aluminum salts.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Carbon Bisulphide.—Through the use of a hot blast, a low blast furnace is operated as a slagging gas producer, anthracite, coke or charcoal being used as fuel. At the bosh, or just above the zone of highest temperature, sulphur vapors are introduced. Carbon bisulphide is formed by contact with the heated carbon, any SO_2 present in the vapors being reduced to CS_2 at the same time. It is even possible to use smelter gases and roaster gases instead of sulphur. The gases and vapors leaving the furnace are cooled in a condenser. This removes most of the moisture coming from the fuel, any sulphur vapor and a little CS_2, the amount of the last depending upon the ratio of its vapors to the gas present. Carbon bisulphide is separated from the cooled mixture of gases and vapors by scrubbing with chilled oil. (1,369,825; KARL P. MCELROY, of Washington; March 1, 1921.)

Electric System for Electric Furnaces.—HARRY A. GREAVES and HARRY ETCHELLS, of Sheffield, England, have devised a system for the practical application of three-phase alternating current to an electric furnace having three (or a multiple of three) upper electrodes and a conductive hearth which is an electrical resistor in one unit. Each of the electrodes is connected to one terminal of the secondary windings of three transformers. The primary windings of the transformers are connected in delta and the secondaries in what is sometimes called an inverted star. The other terminals of the secondary windings and the lead from the hearth of the furnace are connected to a common point. Assuming the transformers to be of identical transforming ratios and the electrodes to be in equal adjustment, equal currents will pass through the secondaries, when the meshed primaries are excited by three-phase currents.

The common resultant current of the three electrodes will pass through the bath of liquid metal and through the resistance hearth of the furnace to the common point. This resultant current will be equal to twice the current passing through any one electrode and consequently any one transformer secondary winding. This arrangement has the additional advantage of making the arcs of a three-electrode furnace on a three-phase system entirely independent of each other, consequently making automatic regulation much more efficient. This also prevents fluctuations on one electrode circuit varying the current in the other electrode circuits. The permanent resistance of the furnace hearth also tends to damp short circuit currents passing through the electrodes, and consequently steadies the load fluctuations of the furnace as a whole. A better power factor is thus more easily maintained, as it is not necessary to introduce so much reactance as in furnaces in which the resistive hearth is not a feature. (1,370,016; March 1, 1921.)

Method of Making Wrought Iron.—Slag distribution in the usual puddle ball or bloom is coarse and the refining incomplete. This necessitates rolling the balls or blooms into bars which are then sheared, piled and re-rolled after heating to welding temperature. According to JAMES ASTON, of Pittsburgh, Pa., these operations may be eliminated by introducing slag into the product of a steel-making process in such a way that uniform slag distribution is obtained. In the preferred method, the molten substantially slagless product of a steel-making process is granulated while dropping through the air and is received in a receptacle containing a bath of molten slag of the proper consistency and temperature, so that a ball of mixed slag and metal will be formed below the surface of the slag in the receptacle. (1,370,507 and 1,370,622; assigned to A. M. Byers Co.; March 8, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Saccharine.—Saccharine is prepared by oxidizing *o*-toluene sulphamide with chromic acid mixed with sulphuric acid of more than 35 per cent strength. The chromic acid may be formed in situ by the use of a chromic acid salt. After cooling and diluting the reaction mixture, the product is filtered off and the saccharine separated from unchanged starting material by any known method. (Br. Pat. 153,520; SOC. CHIMIQUE DES USINES DU RHÔNE, Paris. Jan. 19, 1921.)

Acetic Acid.—In the manufacture of acetic acid by the oxidation of liquid acetaldehyde at 10 to 20 deg. C., the catalyst employed is the residue which remains after igniting the carbon from animal charcoal, with or without the addition of sodium acetate. As the residue mainly consists of calcium and magnesium phosphates, it may be replaced by a mixture of these compounds, with or without small quantities of lime, silicon dioxide and fluorides. (Br. Pat. 154,680, H. DREYFUS, London. Feb. 2, 1921.)

Treating Sulphide Ores of Lead and Zinc.—Sulphide ores of lead and zinc are treated with sulphuric acid containing free sulphur trioxide or with sulphur trioxide in the gaseous form to convert the lead, etc., into sulphates while the zinc remains in the form of sulphide. The lead sulphate is separated from the zinc sulphide, for instance, by flotation. Silver sulphate may be separated from lead sulphate by treatment with water. Cadmium and bismuth if present are converted into sulphates which are readily separated from lead sulphate. (Br. Pat. 154,718, P. A. MACKAY, London. Feb. 2, 1921.)

Potassium Sulphate.—The production of potassium sulphate and hydrochloric acid from a pulverulent mixture of potassium chloride and aqueous sulphuric acid is effected in a single direct-flame furnace having a long flame, and which may be divided into three compartments if necessary, the arrangement being such as to provide for desiccation at a low temperature, say 120 to 300 deg. C., heating at 300 deg. C. and finally heating at 700 to 800 deg. C. Alternatively a compound furnace may be employed allowing the same stages of heating, in which one or more of the stages is effected by indirect heat as in a muffle. In another modification the process is effected in a single furnace so as to obtain first a desiccation at 120 to 300 deg. C. and in the rest of the furnace a temperature increasing from 300 to 800 deg. C., care being taken that the mass moves through the desiccating section slowly enough to remain solid and porous. The sulphuric acid may be of strength exceeding 70 to 72 per cent SO_3. (Br. Pat. 154,111; FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE THANN, France. Jan. 26, 1921.)

Casein Compounds.—Metallic pyrophosphate casein compounds, which are of use in therapeutics, are prepared by dissolving casein in alkali pyrophosphate solution and adding a metallic salt, such as calcium chloride or ferric chloride. (Br. Pat. 154,112; F. HOFFMANN-LA ROCHE & Co., Basel, Switzerland. Jan. 26, 1921.)

Cellulose Acetate.—In the manufacture of solutions, celluloid-like masses, films, dopes, artificial silk and other compositions, and preparations and articles having a basis of cellulose acetate, the following high boiling-point or plastic-inducing agents are employed: Benzene monomethylsulphonamide, benzene methylethylsulphonamide, mixtures of *o*- and *p*-toluene dimethyl- or diethyl- or methylethylsulphonamides, *o*-toluene dimethyl- or diethylsulphonamides, or mixtures of isomeric xylene dimethyl- or diethyl- or methylethylsulphonamides; or mixtures of these dialkylsulphonamides and the monoalkylsulphonamides referred to above or in specifications 132,283 and 133,353 may be used. In conjunction with these high boiling-point solvents there may be used any other suitable low boiling-point solvents, agents such as triphenyl or tricresylphosphate, acid neutralizing aliphatic derivatives of urea such as mono-, di-, or tri-methyl, or triethyl-urea, coloring matters and filling materials. The benzene methylsulphonamide may be prepared from commercial benezene, for example, distilling between 79 and 88 deg. C., the sulphochloride being first prepared and then treated either with ammonia and afterwards with suitable alkylating-agents, or directly with suitable amines; the mixtures of *o*- and *p*-dialkylsulphonamides, from commercial toluene distilling between 95 and 132 deg. C., the *o*-toluene dialkylsulphonamides, from pure toluene distilling between 110 and 111 deg. C.; the mixtures of isomeric xylene dialkylsulphonamides, from commercial xylene distilling between 135 and 146 deg. C. (Br. Pat. 154,334; H. DREYFUS, London, Jan. 26, 1921.)

Electrolytic Detinning Process.—Tin is dissolved from tinned scrap, etc., by a strong solution of tin and iron chlorides, preferably containing a small proportion of hydrochloric acid. A suitable solution is made by treating a 25 per cent solution of ferric chloride with 1 per cent of hydrochloric acid and with metallic tin until it contains 6.5 per cent of stannous chloride and 1.5 per cent of stannic chloride. This solution, after use for dissolving tin from scrap, is electrolyzed to deposit a small amount of tin, equal to that dissolved from the scrap, for instance 0.2 per cent of the solution, the current density and rate of flow and speed of the cathode being regulated to attain this end, and to deposit non-adherent tin, which is scraped off the rotary cathode. The scrap may be placed in two enameled baskets *a*, Fig. 1, hung from the ends of a beam *b* centrally supported by lifting tackle from a carriage *c*. Three pairs of tanks *f*, *g*, *h* are successively used for the treatment, the liquid being admitted from a heater *w* by separate cocks *y* and afterward pumped to a storage tank *u*, whence it is led through a cock *t* to the electrolytic cell *k* and back to the heater. After detinning, the scrap is washed in tanks *i* and coppered or treated with lime water in tanks *j*. The electrolytic cell may comprise an anode *l*, Fig. 2, of trough form and preferably of graphite impregnated with paraffine wax. Copper conductors 2 are embedded in the anode. Electrolyte flows over both edges of

FIG. 1.

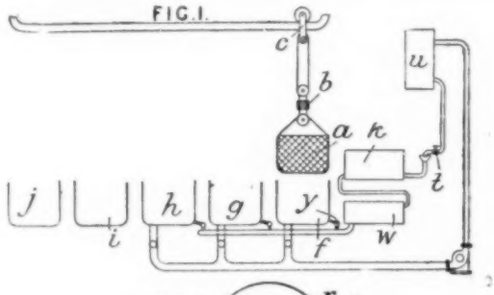
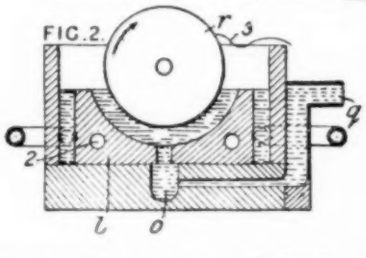


FIG. 2.



the anode into the trough and through holes in the bottom to a well *o* and outlet pipe *q*. The deposited tin is removed from the cylindrical rotating cathode *r* by a scraper 3. The speed of the cathode may be 10 in. per minute, the current density 450 amp. per sq.ft., and the rate of flow 10 gal. per hour through a channel $\frac{1}{2}$ in. x 6 in. between the electrodes. (Br. Pat. 154,242; M. A. ADAM, J. STEVENSON and A. T. MABBITT, all of London. Jan. 26, 1921.)

Acetic Acid.—In the manufacture of acetic acid by the oxidation of liquid acetaldehyde, the catalyst employed is kaolin, with or without the addition of sodium acetate. The temperature is preferably maintained at 10 to 20 deg. C. If, instead of oxygen, gas containing oxygen be employed for the oxidation, it is introduced at a pressure up to 7 atmospheres. (Br. Pat. 154,304; BRITISH CELLULOSE & CHEMICAL MFG. CO., London; M. SOLLER, Ruddington, Nottinghamshire, and J. HOLTZ, Spondon, Derbyshire. Jan. 26, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Final Decree in the Salt Lake Smoke Suits

On March 21, 1921, Federal Judge T. O. Johnson signed various orders setting aside all previous judgments and stipulations regarding the operation of the Murray smelter of the American Smelting & Refining Co. and the Midvale smelter of the United States Smelting, Refining & Mining Co., formerly ordered with a view of avoiding smoke damage to the surrounding country. Based upon the report of Commissioner Robert E. Swain — reviewed at length in CHEMICAL & METALLURGICAL ENGINEERING March 16, 1921, page 463—the court finds that both of these smelting plants can be operated at their present locations without injury to their neighbors, and they are permitted to operate subject to the following conditions:

"1. That all necessary measures shall be taken to maintain all furnaces, flues and other portions of the plant in such good operating condition as to prevent excessive leakage of noxious gaseous or solid emanations.

"2. That all gases and accompanying solid emanations or dusts from roasting or blast-furnace operations shall be subjected to bag filtration, or to electrical precipitation by the Cottrell process, or to any other process or processes of equal efficiency for the removal of suspended solids, sulphur trioxide or sulphuric acid, and that these installations or processes shall be maintained and operated at the highest practicable efficiency; provided, however, that if blast-furnace gases and their accompanying solid emanations or dusts are treated by the Cottrell process, they shall first be conditioned by the addition of sulphuric acid or other modifications in the present process, made to give it an operating efficiency equal to that which it shows in the treatment of the gases and other emanations and dusts from roasting furnaces.

"3. That all gases from roasting operations shall be discharged at a point not less than 450 ft. above the level of the ground, and that through heating apparatus installed at the base of the exit stack, or by other means, there shall be maintained during the growing season for vegetation in this district, during the time each day between sunrise and sunset when roasting operations are in progress, a difference in temperature between the stack gases at any point of measurement within the stack and the outside air amounting to at least 75 deg. C.; provided, however, that upon proper showing to the court, a commissioner may be appointed to receive any submitted evidence and make any necessary investigations, at the expense of the applicant, with a view to the formulation of any modification of the provisions as to temperature of gases hereinabove set out in this paragraph.

"4. The United States Smelting, Refining & Mining Co., one of the defendants, expressed its willingness to make such alterations and improvements in its smelter as to enable it to operate the same subject to the foregoing conditions; it is further ordered that it be permitted to continue to operate subject to the conditions and limitations specifically set forth in the interlocutory decree made on Jan. 21, 1921*, with the proviso that said defendant shall proceed with all due diligence to so alter its smelter as to permit it to operate the same subject to this decree."

National Research Council, Division of Chemistry

The annual meeting of the Division of Chemistry, National Research Council, will be held at Rochester at 12:30 Wednesday, April 27. The various committees will report upon activities of the past year. There will be a general discussion of plans and projects for the ensuing year.

*See "Smoke Litigation in Salt Lake Valley," CHEM. & MET. ENG., vol. 22, p. 1145, June 23, 1920.

Hoover Resigns as President of Engineering Council

At the meeting of the executive board of American Engineering Council in Philadelphia, April 16, noted elsewhere in these columns, Herbert Hoover tendered his resignation as president of American Engineering Council. He did this because he considered that the activities of the council and of the Federated American Engineering Societies in national affairs would be likely to place him in an embarrassing position on account of his Cabinet post. He indicated that his interest in the work of the council and of the federation had in no degree diminished. In fact, he reiterated that he believed the formation of the Federated American Engineering Societies was the starting point of one of the most valuable voluntary services that could be rendered the nation.

His successor as president of the council was not elected at the meeting, but the selection was referred to the consideration of the council's committee on procedure.

Engineering Council's Executive Board Meets

The executive board of American Engineering Council held its regular bi-monthly meeting in Philadelphia on April 16 at which it was decided to hold an "Engineering Assembly" in Washington in January, 1922. The remaining time of the sessions was devoted to the consideration of reports of committees and the reference to these committees of various new matters brought to the consideration of the board.

The "Engineering Assembly" is to be a two-day session for the discussion of engineering problems. A committee was appointed to make arrangments for holding it.

The secretary reported the completion of the moving of the office of the council to Washington, the retention of A. C. Oliphant as assistant secretary, and the engagement of James T. Grady to handle publicity.

The Duluth Engineering Society, the Boston Society of Civil Engineers and the Milwaukee Engineering Society were admitted to membership. The next meeting was fixed for June 3, and, according to previous decision, will be held in St. Louis. W. W. Varney, who has been serving as acting treasurer, was elected treasurer.

The committee on public affairs reported that it deemed it inadvisable for the council to engage in activities with reference to the general reorganization of the government. It believes that the council will be stronger if it confine its efforts to presenting to Congress and the public the merits of the proposal to establish a Department of Public Works.

Investigation of Fertilizers Sold in Pennsylvania

The State Department of Agriculture, Harrisburg, Pa., has concluded an investigation of fertilizers sold in the state during the past year. A total of 1,312 samples was tested, showing a deficiency of 29.9 per cent in one or more of their guarantees for nitrogen, phosphoric acid and potash. The samples represented 676 different brands of fertilizers manufactured by a total of seventy-seven manufacturing companies. The largest proportion of deficiences was found in the complete fertilizers supplying potash, nitrogen and available phosphoric acid.

To Concentrate C.W.S. Work at Edgewood

Training activities and the proving of shells and other ordnance have been conducted on a considerable scale at Lakehurst. In the future these activities will be transferred to Edgewood.

The proving grounds at Edgewood are somewhat limited, but will serve most of the purposes of Chemical Warfare Service tests.

Tentative Program of the Rochester Meeting of the American Chemcial Society

The following program was announced by Secretary Parsons on Friday, April 15:

Monday, April 25

4:00 p.m.—Council Meeting, Rochester Club.
6:30 p.m.—Dinner to the Council at the Rochester Club.

Tuesday, April 26

9:30 a.m.—General Meeting at Chamber of Commerce, 67 St. Paul St.
Addresses of Welcome, Hiram Edgerton, Mayor; E. G. Miner, Chamber of Commerce.
Response, President Edgar F. Smith.
2:00 p.m.—Some Problems of National Defense, Hon. James W. Wadsworth.
The American Chemical Industry, Hon. Nicholas Longworth.
Ammono Carbonic Acids, E. C. Franklin.
Measurement of Color, C. E. K. Mees.
Blue Eyes and Blue Feathers, W. D. Bancroft.
Surface Films as Plastic Solids, R. E. Wilson.
Stability and Structure of Molecules, Irving Langmuir.
Ionization of Electrolytes, G. N. Lewis.
6:30 p.m.—College, Fraternity and Group Dinners.

Wednesday, April 27

9:00 a.m.—Division Meetings, Mechanics Institute, 55 South Plymouth Ave.
8:00 p.m.—Chemistry in the United States, Charles F. Chandler.

Division of Physical and Inorganic Chemistry

Symposium on Contact Catalysis, 9 a.m.

Platinum Black and Carbon Monoxide, F. H. Pollard.

Esterification of Silica Gel, C. H. Milligan and E. Emmet Reid.

Adsorption by Oxide Catalysts and the Mechanism of Oxidation Processes, A. F. Benton.

Dissociation of Some Mixed Oxides, J. C. Frazer.

Adsorption by Metallic Catalysis, R. M. Burns and H. S. Taylor.

The Action of Nickel on Diethyl Ether: A Study in Contact Catalysis. Preliminary Report, F. L. Simons.

R.P.M.'s as a Catalyst, C. H. Milligan and E. Emmet Reid.

Catalysis in the Reduction of Oxides and the Catalytic Combination of Hydrogen and Oxygen, R. N. Pease and H. S. Taylor.

A Case of Autoxidation: $MnO_2 \rightarrow HMnO_4$, J. C. Fraser.

Catalysis in the Interaction of Carbon With Steam and Carbon Dioxide, N. A. Neville and H. S. Taylor.

Oxidation and Reduction by Organic Compounds, C. H. Milligan and E. Emmet Reid.

The Action of Alumina, Titania and Thoria on Ethyl and Isopropyl Acetate, Homer Adkins and A. C. Krause.

Catalytic Electrolytic Oxidation of Sulphur Dioxide, C. G. Fink.

The Decomposition of Ethyl Acetate Induced by Catalytic Nickel, Homer Adkins and P. W. Simmonds.

The Catalytic Influence of Foreign Oxides on the Decomposition of Silver Oxide, Mercuric Oxide and Barium Peroxide, James Kendall and Francis J. Fuche.

Papers at 2:30 P.M.

A New Clock Reaction, G. S. Forbes, H. W. Estill and O. J. Walker.

The Volumetric Oxidation of Sulphide to Sulphate, H. H. Willard and W. E. Cake.

Research for the Undergraduate, Edward Ellery.

The Apparent Irreversibility of the Calomel Electrode, A. W. Laubengayer.

The Theory of Hydrogen Over-Voltage, D. A. MacInnes and W. R. Hainsworth.

The Hydrogen Electrode Under High Pressures, D. A. MacInnes and W. R. Hainsworth.

Potassium Ammonoaluminate and Ammonomanganite, Francis W. Bergstrom.

A Quantitative Study of Adsorption in Solution and at Interfaces of Sugars, Dextrine, Starch, Gum Arabic and Egg Albumen and the Mechanism of Their Action as Emulsifying Agents, G. L. Clark and W. W. Mann.

The Preparation, Properties and Molecular Volume Relationships of the Ammines and Hydrates of Cobalt Fluoride, Bromide, Nitrate, Carbon and Citrate, G. L. Clark and H. K. Buckner.

Emulsification With Soaps of Linoleic and Ricinoleic Acids, G. S. Clark and H. K. Buckner.

Notes on the Preparation of Pure Platinum, Edward Wichers.

Modified Method for the Determination of Iron and Vanadium After Reduction, E. F. Lundell.

The Free Energy of Dilution of Hydrobromic Acid; the Activities of Its Ions in Very Dilute and Concentrated Solutions, H. Miller Spencer and Albert G. Loomis.

Ultra-Violet Arc Spectrum of Yttrium, L. F. Yutema and B. S. Hopkins.

On the Viscosity of Gelatin Sols, R. H. Bogue.

The Structure of the Molecule of Water, Irving Langmuir.

The Purification of Helium by Means of Charcoal, L. Finkelstein.

The Importance of Diffusion in Organic Electrochemistry, Robert E. Wilson.

Observations on the Drying and Swelling of Gelatine Gels, S. E. Sheppard and F. A. Elliott.

Note on the Influence of Silver Salts in Catalyzing the Decomposition of Ammonium Persulphate Solutions, S. E. Sheppard and A. Ballard.

Further Developments of the Hydrogen Electrode, F. A. Elliott.

Note on Silver Soap Gels, Stafford Whitby.

Catalytic Effect in the Reaction Between Ketones and Halogens in Aqueous Solutions, F. O. Rice.

The Transference Numbers of Sulphuric Acid by the Concentration Cell Method, Alfred L. Ferguson.

The Influence of Gelatin on the Transference Number of Sulphuric Acid, Alfred L. Ferguson.

The Entropy of Monatomic Gases, Gilbert N. Lewis.

The Electrometric Titration of Uranium With Potassium Dichromate and Potassium Permangate, D. F. Ewing and E. F. Eldridge.

The Heat of Coagulation of Ferric Oxide Hydrosol by Electrolytes, Frederick L. Brown and J. H. Mathews.

Some Quantitative Experiments on Coagulation of Colloids, Ray V. Murphy and J. H. Mathews.

The Alkalinity of Searles Lake Brine, Roger C. Wells.

The Vapor Density of Technical Phosgene, A. F. O. Germann and Vernon Jersey.

The Cryoscopy of Boron Trifluoride Solutions: V. Systems With Methyl Ether and With Methyl Chloride, A. F. O. Germann and Marion Cleaveland.

The Cryoscopy of Phosgene Solutions: I. System With Chlorine, A. F. O. Germann and Vernon Jersey.

Studies in Fluoride Equilibrium: I. Calcium Borofluoride, A. F. O. Germann and Gilberta Torrey.

Chromatic Emulsions, H. N. Holmes and D. H. Cameron.

Cellulose Nitrate as an Emulsifying Agent, Harry N. Holmes and Don Cameron.

A Theory of the Photographic Latent Image, Harris D. Hineline.

The Interaction of Platinum Hydrochloric Acid and Hydrogen Peroxide, S. A. Braly and O. V. Schoefer.

Is There a Sharp Transition Point Between the Gel and Sol? Eugene C. Bingham.

The Validity of the Additive Fuidity Formula, Eugene C. Bingham and Delbert F. Brown.

The Emulsion Colloids as Plastic Substances, Eugene C. Bingham and William L. Hyden.

The Properties of Cutting Fluids, Eugene C. Bingham.

Division of Industrial and Engineering Chemistry

H. D. Batchelor, chairman; H. E. Howe, secretary.

On Wednesday morning the Division will attend the symposium on contact catalysis held by the Division of Physical and Inorganic Chemistry.

Symposium on Drying, 2 p.m. Charles O. Lavett, chairman

The Rate of Drying Solid Materials (Lantern), W. K. Lewis.

The Theory of Atmospheric Evaporation (Lantern), W. H. Carrier.

The Compartment Dryer (Lantern), W. H. Carrier and A. E. Stacey.

Direct Heat Rotary Drying Apparatus, R. G. Merz.

Tunnel Driers (Lantern), G. B. Ridley.

The Spray Process, R. S. Fleming.

Vacuum Drying (Lantern), Charles O. Lavett and D. J. Van Marle.

General Papers

Tests of Counter-Current Kelp Driers, G. C. Spencer and E. B. Smith.

The Preparation, Properties and Constitution of Liquid and Solid Water-Glasses, Louis Schneider.

Method for Treating Filter Cake Obtained in Refining Vegetable and Animal Oils, Charles Baskerville.

The Application of the Cottrell Precipitator to the Wood Distillation Process, L. F. Hawley and H. M. Pier.

Alcohol and Chemical Industries, J. M. Doran.

The Caustic Calcination of Dolomite and Its Use in Sorrel Cements, C. A. Bole and J. B. Shaw.

Valuation of Oil-Bearing Seeds by Free Fatty Acid of the Oil, Lehman Johnson.

The Detection of Carbon Monoxide (Lantern), C. R. Hoover.

Microscope Illumination With Reference to Brownian Movement and Combination Lighting (Lantern), A. Silverman.

The Relation of Structure to Free Alkali in Sodium Silicate Solutions (Lantern), William Stericker.

Compression Evaporation, A New Method of Concentrating Liquids, Developed in Europe Recently (Lantern), Gustav Carlsson.

Action of Lime on Greensand, R. Norris Shreve.

A Modification of the Acetate Method for Estimating Iron and Aluminum in Phosphates, F. P. Veitch and H. P. Holman.

The Water Resistance of Treated Canvas During Continuous Exposure to Weather, F. P. Veitch and T. D. Jarrell.

The Detection and Estimation of Coal Tar Oils in Turpentine, V. E. Grotlisch and W. C. Smith.

THE CELLULOSE SECTION

9 a.m.

Effect of Adding Various Chemicals to Wood, Previous to Distillation, L. F. Hawley.

The Removal of Free Acid From Nitrated Cellulose, With Special Reference to the Use of Saline Leaches, S. E. Sheppard.

Motor Fuel From Vegetation (Lantern), T. A. Boyd.

Possibilities of the Moist Tropics to Furnish Materials for Cellulose and Carbohydrates (Lantern), H. N. Whitford.

The Possibilities of a Future Fuel Supply From Our Forests, R. C. Hawley.

The Rôle of the Chemist in Relation to Our Future Supply of Liquid Fuel, Harold Hibbert.

The four last-mentioned papers will be discussed together under the general subject, "Our Future Supplies of Liquid Fuel." It is expected that representatives of the Standard Oil Co., U. S. Industrial Alcohol Co., Forest Products Laboratory and others will take part.

The Microstructure of Wood (Lantern), Allen Abrams.

Significance of the So-Called Lignin Tests, E. C. Crocker.

Some Commercial Possibilities of Corn Cob Cellulose, F. B. LaForge.

Nitrocellulose and Its Solutions as Applied to the Manufacture of Artificial Leather, W. K. Tucker.

Influence of Mixed Acids on the Character of Nitrocellulose (Lantern), W. J. Waite.

A Proposal for a Standard Cellulose to Be Available for Research, B. Johnsen.

A Discussion of Some Beater Furnish Reactions From the Standpoint of Colloidal Chemistry, Jessie E. Minor.

The Solubility of Cellulose Acetate in Chlorinated Hydrocarbons, Gustavus J. Esselen, Jr.

The Action of Dry Hydrobromic Acid on Cellulose and Related Derivatives, Harold Hibbert and Harold S. Hill.

The Oxidation of Cellulose, W. S. Holzberger.

European Practice in Cellulose Acetate and Dopes During the War, Philip Drinker.

The Influence of Temperature on Hemi-Cellulose Production, W. E. Tottingham.

The Chemical Changes Involved During Infection and Decay of Wood and Wood Pulp, Mark W. Bray and Joseph A. Staidl.

The Chemical Constitution of Soda and Sulphate Pulps From Coniferous Woods and Their Bleaching Qualities, Sidney D. Wells.

SECTION OF PETROLEUM CHEMISTRY

T. G. Delbridge, chairman; W. A. Gruse, secretary.

9 a.m., Room 112

Organization.

Petroleum Hydrocarbons That Cannot Be Distilled, C. F. Mabery.

Petroleum: A Raw Material for Our Chemical Industries, Sidney Born.

Some Chemical Considerations of Petroleum Refining, B. T. Brooks.

Viscosity-Temperature Curves of Fractions of Typical American Crude Oils (Lantern), E. W. Dean and F. W. Lane.

Determination of Gasoline in Natural and Casinghead Gas, Charles Skeele Palmer.

Dechlorination of Chlorohydrocarbons, W. F. Faragher and F. H. Garner.

Viscosities of Motor Oils at High Temperatures. (By title), L. B. Lockhart.

Oil Shale, R. F. Bacon.

Iodine Numbers of Unsaturated Hydrocarbons and Cracked Gasolines (Lantern), W. F. Faragher, F. H. Garner and W. A. Gruse.

A New Method of Color Measurement for Oils, Leon W. Parsons and Robert E. Wilson.

Total Heats and Condensation Points of Kerosene-Air Mixtures, Robert E. Wilson and D. P. Barnard.

Reclamation of Used Motor Oils (Lantern), W. F. Parish.

Catalytic Oxidation of Petroleum Oils, C. E. Waters.

Accurate Determination of Moisture in Transformer Oils, C. J. Rodman.

DIVISION OF RUBBER CHEMISTRY

W. W. Evans, chairman; Arnold H. Smith, secretary.

9 a.m., Room 109

The first day will be devoted entirely to a discussion of the Tentative Procedure for the Analysis of Rubber Goods.

Thursday

Reports from Executive Committee, Abstract Committee, Accelerator Committee and Physical Testing Committee.

Some Effects of PbO and SO_2 in Zinc Oxide on Compounded Rubber (Lantern), Harlan A. Depew.

Contribution to the Knowledge of the Resins of Hevea Rubber (Lantern), G. Stafford Whitby and J. Dolid.

The Solubility of Gases in Rubber as Affecting Their Permeability, C. S. Venable and Tyler Fuwa.

The Analysis of Rubber Goods Containing Antimony Sulphide, S. Collier and M. Levin.

Reactions of Accelerators During Vulcanization. III. Carbosulphydryl Accelerators and the Action of Zinc Oxide, C. W. Bedford and L. B. Sebrell.

The Influence of Piperidine-piperidyl-dithiocarbamate on Vulcanization (Lantern), G. Stafford Whitby and O. J. Walker.

A Rapid Bomb Method for the Determination of Sulphur in Rubber Compounds, W. W. Evans and Ruth E. Merling.

The Direct Determination of Sulphur of Vulcanization, S. Collier and M. Levin.

Volume Increase of Compounded Rubber Under Strain (Lantern). With comments on the work of H. F. Schippel, Henry Green.

General Round Table Discussion. Topics are: Factory Control of Vulcanization. Testing of Crude Rubber as Received at the Factory. Reactions Between Sulphur and Various Softeners, and others.

DIVISION OF DYE CHEMISTRY

A. B. Davis, chairman; R. Norris Shreve, secretary.

9 a.m.

Contribution to the Estimation of H-Acid, Henry R. Lee.

A New Process for Alizarine, Charles W. Schaffer.

Bleaching of Dyed Cotton Fabrics, J. Merritt Matthews.

The Immediate Needs of Chemistry in America, William J. Hale.

Contribution to the Chemistry of Malachite Green, J. R. Minevtich.

New Developments in American Dyes and Coal-Tar Chemicals in 1920, G. R. DeLong.

Dyes Derived From Beta-Oxynaphthoic Acid and From J Acid With Reference to the Chemical Foundation Patents, A. Willard Joyce.

Quantitative Determination of Phenanthrene, Arthur D. Williams.

Alkali Fusions. III. Fusion of Phenylglycine o-Carboxylic Acid With Potassium Hydroxide and With Sodium Hydroxide for the Production of Indigo, Max Phillips.

Vapor Pressure Determinations on Naphthalene, Anthracene, Phenanthrene and Anthraquinone Between Their Melting and Boiling Points, O. A. Nelson and C. E. Senseman.

Nomenclature of Dyestuff Intermediates, J. W. Kinsman.

Thursday, April 28

9 a.m.—Division Meetings.

7 p.m.—Good Fellowship Meeting, Bausch & Lomb Dining Hall.

Friday, April 29

Excursions, 10 a.m.

Bausch & Lomb Optical Co.

Pfaudler Co.

Gas Plants—Rochester Gas & Electric Corporation.

Municipal Garbage Disposal Plant.

Municipal Sewage Disposal Plant.

Bastian Bros.

Excursions at 2 p.m.

Eastman Kodak Co., Kodak Park Works.
(a) General Excursion.
(b) Synthetic Organic Chemical Department.
Taylor Instrument Companies.
(a) Laboratory Equipment.
(b) Industrial Apparatus.
(c) High Temperature Apparatus.
Vacuum Oil Co.
Bartholomay Co.—Baskerville Refining Process.
Further details concernings the nature of these excursions will be available at the time of registration.

Ladies' Entertainment

A ladies' entertainment is planend for Tuesday afternoon in the Ad Club rooms. The local ladies will give a tea and musical in honor of the visiting ladies. The Goodfellowship Meeting is one at which every lady guest is expected to be present. Among other things there will be dancing.

The Chemical Industry From a Tariff Viewpoint

Speaking before a recent meeting of the Chemical Society of Washington, C. R. De Long, chief chemist of the Tariff Commission, discussed some of the more important questions which arise in tariff consideration of chemical commodities.

Indirect Competition

In addition to direct competition offered by imports of the same chemical it is often necessary to consider indirect competition by similar commodities which are of a competitive nature. One of the most striking examples of indirect competition is afforded by the vegetable oils. Practically any vegetable oil may be used in the manufacture of soap and also, if properly refined, in the manufacture of food products, such as butter and lard substitutes. Taking the case of cottonseed oil: No direct tariff problem is presented by cottonseed oil itself, since it is produced in large quantities and a considerable surplus is exported. However, the indirect competition offered by soya bean and peanut oils is an important factor in the tariff consideration of cottonseed oil. The competition which vegetable oils—in the form of oleomargarine and butter substitutes—offer to the dairy interests is another important consideration in the tariff problems of the vegetable oils.

Compensatory Duties

The problem of compensatory duty, or the adjustment of duties on raw materials and finished products, offers varied tariff problems. These duties are based on the theory that any duty placed on a raw material should be compensated for by a corresponding increase in duty on the finished product. Take, for example, the case of barytes and lithopone. Here we have a case in which the raw material for the manufacture of lithopone was almost exclusively imported before the war. During the war the manufacturers of lithopone were forced to develop domestic supplies of barytes in order to have an adequate supply of raw material. The commission has made a detailed investigation of the cost of manufacturing lithopone and of mining barytes in order to ascertain the extent to which barytes enters into the total cost of lithopone.

Along this same line a study of the relation between the duties on oil seeds and oils show that under the present tariff law there is no definite policy or similar treatment of this important group of commodities. In some cases both the oil seeds and the oils are free of duty. In other cases the duties on the seeds and the oils are so adjusted that there is a differential in favor of importing and crushing the seeds in this country, and in still other cases there is a differential in duties which favors crushing the seeds in foreign countries and importing the oils. In order to have adequate information for considering compensating duties on vegetable oils the Tariff Commission has made a detailed study of the yields obtained in crushing the various oil seeds.

There is a somewhat controversial theory that tariff duties should be based on the difference of cost of production at home and abroad on the assumption that thus a competitive market is increased. In addition to this function costs often serve as an aid in arriving at compensatory duties, which has been previously discussed. Unsettled conditions both in the United States and in foreign countries have made it decidedly questionable whether costs of production have much meaning at the present time. With changing industrial conditions—such as decreases in wages and cost of raw materials—it is also a matter of doubt as to whether or not the cost of production can be obtained with any fair degree of accuracy. The commission, however, has made several investigations as to cost of production in the domestic chemical industry. These include, principally, the cost of producing certain intermediates and dyes, barytes, barium chemicals, lithopone, the cost of refining sugar and the cost of production of ferro-alloys.

In many of the cost investigations the commission has found that the cost varied widely in the same industry and there was very little uniformity in cost-finding methods. In the industries developed as a result of war conditions this situation may be attributed to stress in output without regard to costs or to proper methods of determining costs. These conditions were found particularly in the dye industry and in the manufacture of barium chemicals. It is to be regretted that a large number of chemical firms do not keep adequate cost records and that many of them simply balance their books once a year. About all they really know is whether they made or lost money. It is safe to say that the chemical industries as compared with other industries have been somewhat backward in the exchange of cost ideas and the discussion of problems which are common to all manufacturers. It is to be hoped that if the commission's investigations have accomplished nothing else they have started manufacturers to thinking more about costs and exchanging ideas in regard to cost methods. There is true in the case of the dye industry, which has had a committee studying uniform costs and has issued a comprehensive report on this subject. In addition, many firms have established adequate cost-finding methods as a result of the Tariff Commission's investigations.

The Tariff Commission can be of service to domestic manufacturers in presenting their cases to Congress. Very few manufacturers are willing to disclose their individual costs in a public hearing before committees of Congress. The commission has, however, found domestic manufacturers always willing to submit their costs to the commission in confidence, so that the commission can tabulate and compare individual costs and thus arrive at an average cost or at a method of presenting individual costs which would not reveal confidential information of the individual manufacturer.

Tariff Classification of Chemicals

An attempt to classify chemical commodities for tariff purposes presents many technical and difficult problems. Classification may be by specific mention, that is, enumeration by name. In this connection it must be remembered that trade and commercial designations prevail over scientific nomenclature and that details such as punctuation may affect court interpretations. In the past, specific mention of chemical commodities was necessary in order to obtain import statistics and therefore the more chemical commodities which were mentioned by name the more detailed were the imports of chemicals shown.

Another method of classifying chemicals is by the law of similitude. This method is probably more unfamiliar to the ordinary layman than any other. If an article is not mentioned by name in the tariff law, the next question to be decided is whether or not it is like some other article which is mentioned. The law of similitude requires that an article must be like another article in one of four particulars—namely, material, quality, texture or use. This law is further restricted in that it can be only applied to dutiable goods—that is, a chemical commodity cannot be exempted from duty because it is similar to an article specifically mentioned on the free list.

If an article is not free or dutiable, either by specific mention or by similitude, it must be classed under some general provision. The tariff laws contain provisions known as "basket clauses" such as "all other aluminum compounds" and "all chemical and medicinal compounds, preparations,

mixtures and salts." If an article is not duitable or free under some such provision as a last resort to obtain revenue, customs officials usually class it under paragraph 385 as an unenumerated, unmanufactured article, or as an unenumerated manufactured article. In many of these general provisions in the tariff act the classification depends upon use. Such classification is one of the most difficult to administer. For example, at the present time tanning extracts are free of duty while all dyeing extracts are dutiable, although in many cases these products overlap in use.

Specific Versus ad Valorem Duties

The question as to what kind of duties should be levied on any given commodity—that is whether specific or ad valorem (based on value)—is a controversial one. However, it should be pointed out that in particular cases either a specific or an ad valorem rate has certain advantages. General ad valorem duties are objected to on the theory that it offers a chance for undervaluation on imports and at the present time they would be assessed on depreciated currency, as under the present law all ad valorem duties are assessed on the foreign market value. On the other hand, it is evident that in the case of goods varying widely in value an ad valoreum duty would bear more evenly on the different articles or different grades of a chemical commodity than would a specific duty.

Reclassification of Chemicals

Some of the difficulties of classifying chemicals from a tariff standpoint have been cited and the question arises as to how the difficulties may be overcome. As a result of the commission's study in the chemical industries it has collected much information which would be of service in solving many of these difficulties of classification. At the present time, the chemical division of the commission is engaged in a reclassification of chemicals in Schedule A and those chemicals in the free list. An attempt is being made to eliminate conflicts in language which have caused frequent litigation in the past; to eliminate old and obsolete terms in chemical commodities, and to substitute chemicals which have become of commercial importance since the passage of the act of 1913. Even with the information and experience which has been gleaned in the past three or four years, it is hardly possible to write a tariff classification and description of chemical commodities which will entirely eliminate possible litigation. Certain changes in language can be made, however, which will reduce litigation to a minimum. Such a report on reclassification of chemicals has been nearly completed by the Tariff Commission and is to be presented to the Committee on Ways and Means as an aid in the present tariff revision.

A.C.S. Committee to Visit Edgewood

The American Chemical Society's committee which is co-operating in an advisory capacity with the Chemical Warfare Service will spend April 22 and 23 at Edgewood Arsenal. The object of the visit is to obtain first-hand impressions as to the progress of the work and to discuss current problems with the scientific staff at the arsenal. By making the visit at that time, the members of the committee will have the advantage of knowing the latest developments in all phases of the work, making them better able to consult with many other chemists in regard to it at the Rochester meeting.

Award of Willard Gibbs Medal to Mme. Curie

The Chicago Section of the American Chemical Society will hold a function of unusual interest this year in the presentation of the Willard Gibbs Medal to Mme. Marie Curie on June 14. Plans are under way for staging a brilliant affair under the leadership of the chairman, Dr. W. Lee Lewis. Large committees of reception composed of members of the section, representatives of foreign governments and city officials are being organized. Mme. Curie on this occasion will deliver an address of interest at once to scientists and laymen.

Argument on Minerals Separation Supplemental Bill

On April 2 the United States District Court at Wilmington, Del., heard arguments on the supplemental bill through which Minerals Separation, Ltd., seeks to have Minerals Separation North American Corporation made a party plaintiff in the Miami suit. The testimony had previously been taken and various documents placed in evidence.

The controversy concerns an agreement of July 8, 1913, between Minerals Separation, Ltd., and Minerals Separation North American Corporation and relates to whether this agreement did or did not constitute a sale of the patents of Minerals Separation, Ltd., or whether it was nothing more than a transfer to Minerals Separation North American Corporation of the equitable rights in those patents, leaving Minerals Separation, Ltd., the legal owner. The debatable points for the most part appear to be legal technicalities as to whether a certain transaction constituted an actual sale through which ownership of the patents passed from Minerals Separation, Ltd., to Minerals Separation North American Corporation at a time prior to the filing of the Miami infringement suit. If decided in the affirmative, the Miami suit would be dismissed. The controversy also centers in the question as to whether the failure of Minerals Separation North American Corporation to make the required disclaimer as to the claims of its patent which were declared invalid by the U. S. Supreme Court may not affect the rights of Minerals Separation, Ltd., to bring suit under the patent.

Weeks Considering Nitrate Division's Report

The Secretary of War is giving personal consideration to the question of continuing the Fixed Nitrogen Laboratory which the Department is conducting at American University, Washington, D. C. A full report on the needs of such a laboratory has been submitted by Major J. H. Burns, who is in charge of the Nitrate Division of the Ordnance Department. Secretary Weeks advised the Washington correspondent of Chemical & Metallurgical Engineering on April 13 that he had not reached a decision in the matter. He also stated that he had not made up his mind as to whether it is better to try to maintain the nitrate plants at Muscle Shoals in standby condition or whether there is a possibility of devising some means for their operation.

American Oil Chemists' Society to Meet in Chicago

The annual convention of the American Oil Chemists' Society will be held May 16 and 17 in Chicago, with headquarters at the Congress Hotel. Among the prominent chemists who will address the meeting is Dr. C. L. Alsberg, of the Bureau of Chemistry. The entertainment committee, with L. M. Tolman, chief chemist of Wilson & Co., as chairman, has planned numerous excursions, besides the usual banquet, which will occur on Tuesday evening.

As there are many chemists in and near Chicago interested in edible and technical oils and fats, the attendance promises to be larger than usual this year.

Thomas B. Caldwell of Wilmington, N. C., the secretary of the society, will be glad to furnish anyone interested with further details.

Protective Tariff Asked for South's Minerals

A formal request for a protective tariff on a number of mineral products produced in the South has been asked by representatives of these industries who appeared recently before the sub-committee on metals of the Ways and Means Committee. Schedules which will insure the development of the following minerals were asked: Asbestos, barytes, bauxite, clay, gypsum, graphite, marble, monazite, manganese, mica, potash, pyrites, quicksilver, sulphur, talc and zinc.

The Southern Tariff Association assisted in presenting the case. It was declared that nothing short of adequate duties would enable the development of the great mineral resources of the South, particularly the non-metallic minerals.

Book Reviews

THE DETERMINATION OF HYDROGEN IONS. By *W. Mansfield Clark.* 318 pp., illustrated. Baltimore: Williams & Wilkins Co., 1920. Price, $5.

The most striking advance in analytical technique of the last five years has been in the exact determination of hydrogen ion concentrations, and, concomitantly, one of the most significant contributions of chemistry to the biological sciences and to a host of chemical applications has been the clear distinction between "available acidity" and "effective acidity," also called "total" and "actual" acidities, though Clark uses none of these terms. The determination of total, available or "titrable" acidity by titration has long been common practice, though with difficulty in colored, turbid or "buffer" media. The determination of how much of this acidity is present as actual hydrogen ions, and therefore effective, is recent, and the methods developed have been invaluable.

In this development Dr. W. Mansfield Clark has played a leading part, and this book embodies the experience of a master. It is thorough, both in theory and in laboratory suggestions, precise, and replete with references. The bibliography alone (64 pages) justifies the book. The theory presented is complete and rigorous; no pains are spared to discuss every possible difficulty in the methods; insidious errors are elucidated.

A list of chapter headings will prove this point: Some general relations among acids and bases; outline of the chief calorimetric procedure; theory of indicators; choice of indicators; standard buffer solutions for colorimetric comparisons; approximate determinations with indicators; outline of the electrometric method; theory of the hydrogen electrode; potential differences at liquid junctions; hydrogen and calomel electrodes and electrode vessels; the potentiometer and accessory equipment; hydrogen generators, wiring, shielding, temperature control, purification of mercury; the relation of hydrogen electrode to reduction potentials; sources of error in electrometric measurements of p_H; standard solutions for checking hydrogen electrode measurements; standardization of p_H measurements; supplementary methods; applications; bibliography.

Addressed to research workers in the biological sciences, the book admirably fulfills its purpose and equips them for the justly feared task of determining p_H to the third decimal. It makes usable the excellent precise apparatus developed by American manufacturers. Its strength in this aspect is, however, rather an obstacle to chemists. Except in biological media the third decimal of the p_H value is not significant, and the corresponding measurement of voltage to the fourth decimal is wholly unnecessary. While dangers and pitfalls are faithfully pointed out, no safe path is recommended. Full discussions of the effect on the fourth decimal of the purification of calomel and the size of calomel grains, etc., which form the mass of the book—protein errors, salt errors, and a host of others—give the unfortunate impression that the determination of hydrogen ions is a tremendous task and one to be undertaken only by those whose funds and time and intellect are unlimited.

This is unfortunate both because p_H measurements to the first decimal are actually among the easiest of all chemical determinations either by calorimetric or by electrometric means, and because such determinations when thus simply made give valuable information in almost numberless cases. It is not improbable that the majority of industrial acidimetric titrations, which give total acidity, should be replaced by measurements of the actual or effective acidity. Yet the needs of the industrial chemists are not considered in this book. The reviewer therefore regrets that Dr. Clark did not add a few brief chapters on simplified theories, methods and applications, for which there is such a demand. The fact remains, however, that he has produced a book that for many years will be indispensable to research workers.

GERALD L. WENDT.

Personal

HUBB BELL has left the Pittsburgh Testing Laboratory and is now with the United States Testing Co., Inc., 316 Hudson St., New York City.

RALPH W. BOYD has resigned as chemist of the metallurgical research department of the Colorado School of Mines and is now associated with the Desert Shale Oil Corporation of Salt Lake City.

WALTER E. DALY, secretary and treasurer of the Pioneer Alloy Products Co., will leave for Rio de Janeiro and Buenos Aires the first part of May.

F. P. GEYER, chief geologist of the Maryland Refining Co., Ponca City, Okla., has been elected a director of the company, succeeding J. Dawson Callery, resigned.

Major ADELNO GIBSON, who has been on duty with the General Staff, has been ordered to report to the chief of the Chemical Warfare Service.

Dr. FREDERICK GOWLAND HOPKINS, professor of biochemistry at Cambridge University, England addressed the students of Johns Hopkins Medical School, Baltimore, Md., on April 12.

B. F. JONES has resigned as president of the Republic Rubber Co., Youngstown, Ohio.

Dr. R. E. ROSE, director of the technical laboratory of the dyestuffs department of E. I. du Pont de Nemours & Co., Wilmington, Del., gave an interesting address on April 5 at Wilmington in connection with the showing of motion pictures of the company's dye works for the first time.

Dr. ALONZO E. TAYLOR, professor of physiological chemistry at the University of Pennsylvania, and JOSEPH S. DAVIS, assistant professor of economics at Harvard, have been named directors of the Food Research Institute, which is to begin work at Stanford University on July 1, under the direction of Dr. C. L. Alsberg, now chief of the United States Bureau of Chemistry.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 18, 1921.

The chemical market during the past week has shown no unusual activity. Individual transactions have been mostly of a small nature with a moderate exchange of carlots in some of the more important items. There was a better call noted for medicinal chemicals, but these were sold mostly in small quantities and the volume has not been of large dimensions. The general condition of the market with all its adversities, however, has improved.

Among some of leading factors opinions are quite cheerful regarding the outlook. This no doubt is due to a renewal of buying interest. Although March and April sales have been better than those in preceding months, no one is impressed with the idea that any rapid revival of business can take place. The long drawn-out interval of liquidation, with all its depressing influences, will not permit a quick recovery. There will be temporary intermittent periods of dullness and activity but indications favor an increase more than a decrease in business.

Manufacturers are finding more requests for *caustic soda* and *soda ash*. The latter chemical has been in fair demand for several weeks. Sales have been recorded to Mexico and South American countries and seem to be increasing daily. Domestic textile mills have bought caustic, while a better call for dense ash is being felt from the glass industry. The broadening out of the demand for these two big basic chemicals is very significant, as they are considered by many to be the best barometers to the chemical situation.

There have been reports of purchases of German *caustic potash* at 8@9c. per lb. by prominent consumers. The resale American grade, 88-92 per cent, is to be had as low as 7½@8½c. per lb. Domestic producers are still holding their price up to 12½c., but admit they cannot compete under the relatively high overhead expenses here. Foreign *muriate of potash* is being offered at prices which make it difficult for the domestic makers to sell, and it is understood that plants here have closed down at some points. Foreign *bleach* has been sold in large quantities at 2½c. per lb. N. Y. and *oxalic acid* for shipment from abroad has been offered at 16c. per lb. Paper mills have bought *bleaching powder* at 2¼@2½c. in large drums, although producers are asking as high as 2¾c. *Citric acid* has continued to show strength under higher cable advices from primary points abroad. Several inquiries have reached the market for *arsenic*, but actual business has not been large. *Cyanide of soda* has attracted attention, with the American grade in strong demand.

In general it can be stated that business conditions throughout show many unmistakable signs of improvement. There is in all probability a great deal of liquidation to be accomplished. There is still a vast amount of frozen credit that must be thawed out. The big thing that must be accomplished is the revival of our export business. There is much encouragement noted in Washington at results obtained by the War Finance Corporation on export credit.

General Chemicals

More activity for standard *bichromate of soda* on spot is reported by dealers. Sales went through at 7¾c. per lb. and it is doubtful if this price could be shaded on any sizeable quantities. It is stated that a number of 5 and 10 ton lots have been sold and quite a little business could be placed at 7½c. per lb. if sellers would meet these figures. Holders are showing a disposition to tighten up offerings on first appearances of real business. White granular *sal ammoniac* is offered by importers as low as 6½@7½c. per lb. on spot. Makers are holding their prices around 10c. for this grade. *White arsenic* is quoted at 8@8½c. per lb., according to quantity and seller. Business has been slower than the season justified. Recent sales of large lots of *acetate of lime* at $1.50 per 100 lb. have cleaned up the greater part of stocks offered at this figure, although there still remain some supplies that can be purchased at this level on a firm bid. Openly quoted prices are now around $2 per 100 lb. The sale of this material at concessions has demoralized the acetic acid market to a great extent. *Muriate of potash* prices are lower on the spot following the offers of heavily distressed lots. Quotations around $52@$55 per ton are heard for prompt delivery. Lower prices are named for imported prussiates. *Red prussiate of potash* is quoted lower at 35@40c. per lb. *Yellow prussiate of potash* is offered freely at 26@28c. per lb. Manufacturers' prices on *soda ash* are held steady at $1.72½ per 100 lb., basis 48 per cent, f.o.b. works, in single bags. The spot market for domestic material is around $1.95@$2.05 per 100 lb. Resale offerings of *nitrate of soda* are heard lower, in spite of recent advances announced by importers to $3 per 100 lb. Spot material can be had as low as $2.50 per 100 lb. It is hard at present to say which course the market will take, although resale stocks are known to be fairly heavy. Resale lots of *formaldehyde* have reached the market at 14c. per lb. and sales have been recorded from this figure up to 15c. It is stated that a considerable amount of small sales has been transacted for agricultural purposes.

Coal-Tar Products

Trading in the coal-tar products market during the past week has continued without feature and with very slow demand. Buying has been on a strictly limited scale, with most consumers afraid to lower prices and consequently refusing to take on stocks of any magnitude. Manufacturers are looking forward with great fear to the action at the present session of Congress on the dye question which will probably either make them or break them. Producers seem to be awaiting the word of Congress before junking their plants or initiating extensive building operations.

Prices as a rule have held fairly steady in spite of the lack of interest. Resellers can be found who will cut any price quoted on the slightest show of interest from a prospective buyer, but this attitude is almost entirely absent from the producers' market, where it is felt that concessions should be given only in the face of firm business. Makers have reduced prices on *dinitrobenzene* and *dinitrochlorbenzene*. Producers of *beta naphthol* are holding their quoted price at 40@45c. per lb., although spot lots are still be had as low as 32@34c. per lb. Business has been very slow, and it is understood that while spot stocks are being gradually moved into consuming channels, enough is still available to last for some time at the present rate of movement.

Sodium Compounds During 1919 and 1920

According to figures compiled by R. C. Wells of the U. S. Geological Survey, Department of the Interior, the production imports and exports of sodium compounds all increased in 1920 over 1919. The following table shows the complete sales of the individual products sold in the United States in 1919 and 1920:

Product	1919	1920
	Short Tons	
Sodium acetate	778	1,020
Sodium bicarbonate	134,962	188,906
Sodium bichromate	26,526	25,973
Sodium bisulphite	11,819	22,059
Soda ash	981,054	1,242,490
Salsoda	80,090	62,857
Sodium hydroxide	311,388	382,680
Sodium nitrite	676	140
Sodium phosphate	14,760	30,615
Sodium silicate	300,138	304,503
Salt cake	134,685	184,946
Glauber's salt	42,087	44,479
Niter cake	83,402	398,638
Sodium sulphide	45,448	42,952

Sodium bichromate, nitrate and salsoda were the only compounds that showed considerable decreases in 1920. Several of the compounds made good advances over 1919 and sodium bicarbonate, bisulphite and phosphate made new records.

The following table gives the exports of domestic sodium compounds for 1919 and 1920. It will be noted that good increases were made in 1920. Japan, Canada and Mexico were the leading consumers of our exports:

Product	1919	1920
	Short Tons	
Sodium bicarbonate	.....	10,321
Soda ash	50,481	8,338
Salsoda	5,563	6,015
Sodium chloride	119,416	139,278
Sodium hydroxide	82,118	112,069
Sodium silicate	12,150	17,048
Sodium borate	.....	7,163

The Iron and Steel Market

PITTSBURGH, April 15, 1921.

After several weeks in which developments were distinctly unimportant the steel market has in the past week exhibited some very interesting movements. The independents, which had been quoting prices well below the Steel Corporation or Industrial Board prices, advanced their prices slightly and then the Steel Corporation reduced its prices, whereby the corporation and independents are on the same price level, a condition that has existed only occasionally since the period of Government control.

Prices in Detail

By an announcement made late on April 12 the Steel Corporation reduced its prices as follows: Bars, from 2.35c. to 2.10c.; shapes, from 2.45c to 2.20c.; plates, from 2.65c. to 2.20c. Nails were reaffirmed at $3.25, base, per keg, while plain wire was set at 3c. That had been the Industrial Board price, but in August, 1919, the corporation had advanced to 3.25c. Tin plate was reduced from $7 to $6.25, per base box, 100-lb. A week ago independent prices were 2c. on bars and 2.10c. on shapes and plates, in carload lots, while concessions below these prices were obtainable on larger lots. Nails had been $3 in the independent market.

Yesterday the American Sheet & Tin Plate Co. decided upon its new prices for sheets, blue annealed being reduced from 3.65c. to 3.10c., black sheets from 4.35c. to 4c. and galvanized sheets from 5.70c. to 5c. The independent market a week ago was 2.80@2.90c. on blue annealed, 3.75c. on black and 4.75@4.80c. on galvanized.

Tubular goods, hoops and a number of other commodities remain to be acted upon by the Steel Corporation.

Wages

With these reductions in prices the Steel Corporation does not reduce wages. The independents have made various reductions, beginning early last December, and in general are paying rates about 20 per cent below the old scale, maintained by the corporation. The corporation had been expected to reduce wages when it should reduce prices, but the present reductions are not as great as the corporation was expected eventually to make. Probably the corporation had hoped for a time that eventually one single reduction could be made that would put the market on a stable basis for a long period, but that plan had to be abandoned. Also, the corporation had been working on plans to eliminate the 12-hour day, it being presumably the intention to make the change in working conditions at the same time as the wage rates were changed, and this change is likewise deferred.

Operations and Orders

The Steel Corporation's operations are now at about 40 per cent, on the basis of ingot production to capacity, having decreased from an average of 90 per cent in January. Independent mill operations are now at about 35 per cent of capacity. Practically all reports and estimates in the trade have understated the rate of independent mill operations since the first of the year, this being perhaps a psychological phenomenon. There is good reason to believe the independents operated at about 30 per cent in both January and February and at about 32 per cent in March.

The reductions by the Steel Corporation are likely to bring the corporation a good batch of "releases" against suspended orders and of specifications against contracts, whereby corporation operations may increase somewhat in the next few weeks, say to 50 per cent. Report has it that in advancing their prices the independents secured closing of a number of orders on quotations they had outstanding, and thus the independents may run slightly better in the next few weeks, without booking much additional business now.

It is idle, of course, to expect the price reductions of the Steel Corporation and the equalization in the market to produce much if any additional consumption of steel. A rough classification is that steel is bought by railroads for their own use, by investors for construction purposes, and by manufacturing consumers for making into wares which they sell. As to the railroads, they cannot be interested, since their present position is that they cannot pay for all the rails they had already ordered for this year. As to investors, they are waiting on better financial conditions and lower wage costs in construction work. As to manufacturing consumers, they must sell their wares if they buy steel, whatever the price of the steel.

Pig Iron

The pig iron market remains stagnant. There are stocks of basic iron in the hands of steel works which the steel producers would be willing to sell. Although only about a score of merchant blast furnaces are in operation in the whole country, there are merchant stocks of considerable size, since many furnaces accumulated iron before they went out. The foundries have been reducing their stocks, but their operations appear to have decreased materially in the past few weeks. Quotations, largely nominal, remain at $25 for bessemer, foundry and malleable, at $23 for basic, f.o.b. valley furnace, freight to Pittsburgh being $1.96.

Coke

It is learned that the recent sale of a round block of Connellsville furnace coke to the furnace at Portsmouth, Ohio, was at $3.50 instead of at $3.75, the price first reported, and another furnace interest has since bought about 1,000 tons at $3.50, so that the market seems established at that figure, a price as low as can be expected and representing a very fair liquidation in this item of the cost of making pig iron.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.13 – $0.13½	.13½ – .14
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.75	3.00 – 3.25
Acetic, 56 per cent	100 lbs.	4.00 – 4.25	4.50 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.50 – 9.75	10.00 – 10.50
Boric, crystals	lb.	.13½ – .14	.14½ – .15
Boric, powder	lb.	.15 – .15½	.16 – .16½
Citric	lb.	..... –	.47 – .50
Hydrochloric	100 lb.	1.60 – 1.75	2.00 – 2.20
Hydrofluoric, 52 per cent	lb.	.13 – .13½	.14 – .14½
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06¼ – .06½	.07 – .07½
Nitric, 42 deg	lb.	.07¼ – .07½	.07½ – .08¼
Oxalic, crystals	lb.	.16½ – .17	.18 – .19
Phosphoric, Ortho, 50 per cent solution	lb.	.17 – .17½	.18 – .19
Picric	lb.	.30 – .32	.35 – .40
Pyrogallic, resublimed	lb.	..... –	1.90 – 2.15
Sulphuric, 60 deg., tank cars	ton	..... –	..... – .....
Sulphuric, 60 deg., drums	ton	..... –	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	19.00 – 20.00	..... – .....
Sulphuric, 66 deg., drums	ton	22.00 – 22.50	23.00 – 23.50
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – .....
Tannic, U. S. P.	lb.	..... –	1.00 – 1.10
Tannic (tech.)	lb.	.50 – .52	.54 – .57
Tartaric, crystals	lb.	..... –	.36 – .40
Tungstic, per lb. of WO	lb.	..... –	1.30 – 1.40
Alcohol, Ethyl	gal.	..... –	4.90 – 5.25
Alcohol, Methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.36 – .40
Alcohol, denatured, 190 proof	gal.	..... –	.40 – .45
Alum, ammonia lump	lb.	.04 – .04¼	.04½ – .04¾
Alum, potash lump	lb.	.05½ – .06	.06½ – .07
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.02¼ – .02½	.02¾ – .03
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 – .07½	.07¾ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07½ – .08	.08½ – .10
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.06½ – .06¾	.07 – .07½
Ammonium chloride, granular (gray salammoniac)	lb.	.08½ – .08¾	.09 – .09½
Ammonium nitrate	lb.	.08 – .08½	.09 – .10
Ammonium sulphate	100 lb.	2.75 – 2.85	2.90 – 3.00
Amylacetate	gal.	..... –	4.00 – 4.25
Amylacetate tech	gal.	..... –	3.00 – 3.25
Arsenic oxide, (white arsenic) powdered	lb.	.08 – .08½	.09 – .10
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 – .12½	.13 – .14
Barium chloride	ton	60.00 – 65.00	70.00 – 75.00
Barium dioxide (peroxide)	lb.	.19 – .20	.21 – .22
Barium nitrate	lb.	.11 – .11½	.12 – .12½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		..... –	..... – .....
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.40 – .41	.42 – .45
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04½	.05 – .05½
Calcium chloride, fused, lump	ton	27.00 – 29.00	30.00 – 32.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02¼
Calcium hypochlorite (bleach'g powder)	100 lb.	2.40 – 2.60	2.75 – 3.00
Calcium peroxide	lb.	..... –	1.25 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.63 – .65
Carbon bisulphide	lb.	.07 – .07½	.07½ – .08
Carbon tetrachloride, drums	lb.	.10 – .10½	.11 – .12
Carbonyl chloride (phosgene)	lb.	..... –	.75 – 1.00
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	..... –	.38 – .40
Cobalt oxide	lb.	..... –	3.00 – 3.10
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	.23 – .24	.25 – .27
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05½ – .05¾	.06 – .06½
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	.90 – 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)		..... –	..... – .....
Formaldehyde, 40 per cent	lb.	.14 – .14¼	.14½ – .15
Fusel oil, ref.	gal.	..... –	3.25 – 3.50
Fusel oil, crude	gal.	..... –	1.75 – 2.00
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.17 – .17½
Iodine, resublimed	lb.	..... –	3.75 – 3.85
Iron oxide, red	lb.	..... –	.10 – .20
Iron sulphate (copperas)	100 lb.	.75 – 1.00	1.10 – 1.25
Lead acetate,	lb.	..... –	.11½ – .13½
Lead arsenate, paste	lb.	.08½ – .09	.09½ – .10
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08½ – .09	.09½ – .10
Lithium carbonate	lb.	..... –	1.25 – .....
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .13
Magnesium sulphate, U. S. P.	100 lb.	2.75 – 3.00	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	2.25 – 2.50
Methanol, 95%	gal.	..... –	.75 – .77
Methanol, 97%	gal.	..... –	.78 – .82
Nickel salt, double	lb.	..... –	.13 – .13½
Nickel salt, single	lb.	..... –	.14 – .14½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.35 – .40
Potassium bichromate	lb.	.12 – .12¼	.12½ – .13

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ ... – $....	$0.30 –$0.35
Potassium bromide, granular	lb.	... – ...	.20 – .40
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.06½– .07	.08 – .09
Potassium chlorate, crystals	lb.	.07½– .08	.09 – .14
Potassium cyanide	lb.	... – ...	.32 – .35
Potassium hydroxide (caustic potash)	lb.	.08 – .08½	.09 – .10
Potassium muriate	ton	52.00 – 55.00	... – ...
Potassium iodide	lb.	... – ...	2.75 – 3.00
Potassium nitrate	lb.	.09¼– .09½	.10 – .12½
Potassium permanganate	lb.	.35 – .37	.39 – .40
Potassium prussiate, red	lb.	.35 – .37	.38 – .40
Potassium prussiate, yellow	lb.	.26 – .27	.28 – .29
Potassium sulphate (powdered)	per unit	... – ...	1.75 – 1.80
Rochelle salts (see sodium potas tartrate)		... – ...	... – ...
Salammoniac (see ammonium chloride)		... – ...	... – ...
Sal soda (see sodium carbonate)		... – ...	... – ...
Salt cake	ton	... – ...	32.00 –34.00
Silver cyanide	oz.	... – ...	1.30 – 1.35
Silver nitrate	oz.	... – ...	.39 – .40
Soda ash, light	100 lb.	1.95 – 2.10	2.15 – 2.40
Soda ash, dense	100 lb.	2.20 – 2.30	2.40 – 2.60
Sodium acetate	lb.	.04½– .05	.05½– .06
Sodium bicarbonate	100 lb.	2.50 – 2.60	2.70 – 3.00
Sodium bichromate	lb.	.07¾– .08	.08¼– .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05½– .05½	.05¾– .06
Sodium borate (borax)	lb.	.06½– .06¾	.07 – .07¼
Sodium carbonate (sal soda)	100 lb.	1.90 – 2.00	2.25 – 2.50
Sodium chlorate	lb.	.08½– .09	.09½– .10
Sodium cyanide, 96-98 per cent	lb.	.19 – .20	.21 – .30
Sodium fluoride	lb.	.12 – .12½	.13 – .14
Sodium hydroxide (caustic soda)	100 lb.	3.65 – 3.75	3.80 – 4.00
Sodium hyposulphite	lb	... – ...	.03½– .04
Sodium nitrate	100 lb.	2.50 – ...	2.60 – ...
Sodium nitrite	lb.	.06 – .06½	.06½– .07
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½– .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	... – ...	.27 – .28
Sodium prussiate, yellow	lb.	.12½– .12¾	.13 – .13½
Sodium silicate, solution (40 deg.)	lb.	1.25 – 1.35	1.40 – 1.50
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½– .03¾
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05½– .05¾	.06 – .06½
Sodium sulphite, crystals	lb.	.04 – .04½	.04½– .05
Strontium nitrate, powdered	lb.	.16 – .16	.17 – .18
Sulphur chloride, red	lb.	.07 – .07½	.07½– .08
Sulphur, crude	ton	20.00 –22.00	... – ...
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	... – ...	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	... – ...	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	... – ...
Tin oxide	lb.	... – ...	.40 – .42
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.11 – .11½	.11½– .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½– .14
Zinc oxide, XX	lb.	.08½– .09	.09½– .10
Zinc sulphate	lb.	.03½– .03¼	.04 – .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.15 — $1.25
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.20 — .26
Aniline salts	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.50
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .80
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.28 — .30
Benzyl chloride, tech	lb.	.25 — .27
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.33 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.90 — .95
Cresylic acid, 95-97%, dark, in drums	gal.	.85 — .90
Cresylic acid, 50%, first quality, drums	gal.	.55 — .60
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.25
Dimethylaniline	lb.	.48 — .55
Dinitrobenzene	lb.	.32 — .35
Dinitroclorbenzene	lb.	.20 — .30
Dinitronaphthalene	lb.	.30 — .40
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums	gal.	.40 — .45
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.20 — 1.25
Monochlorbenzene	lb.	.14 — .16
Monoethylaniline	lb.	1.75 — 1.85
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08½— .09¼
Naphthalene, balls	lb.	.09½— .10½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.17 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.75 — 1.85
Para-amidophenol, HCl	lb.	2.00 — 2.10
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.90 — 1.05
Para-nitrotoluene	lb.	.85 — 1.00
Para-phenylenediamine	lb.	1.95 — 2.00
Para-toluidine	lb.	1.25 — 1.60
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.11 — .13
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.75 — 1.85
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22 — .23
Salicylic acid, U. S. P.	lb.	.21 — .22
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.35 — 1.45
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 — ...
Xylene, commercial, in drums, 100 gal	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ...

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.26
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, Flora	lb.	.68 — .70
Carnauba, No. 2, North Country	lb.	.30 — .32
Carnauba, No. 3, North Country	lb.	.18 — .19
Japan	lb.	.19¼— .19½
Montan, crude	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04 — ...
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03 — ...
Paraffine waxes, refined, 118-120 m.p.	lb.	.04 — .04¼
Paraffine waxes, refined, 125 m.p.	lb.	.04½— .04¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.05 — .06
Paraffine waxes, refined, 133-135 m.p.	lb.	.06 — .06½
Paraffine waxes, refined, 135-137 m.p.	lb.	.06½— .06¾
Stearic acid, single pressed	lb.	.11 — ...
Stearic acid, double pressed	lb.	.11½— ...
Stearic acid, triple pressed	lb.	.12 — .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.37
Pinewood creosote, ref	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl	280 lb.	$4.90	— ...
Rosin E-I	280 lb.	5.15	— ...
Rosin K-N	280 lb.	5.50	— ...
Rosin W. G.-W. W	280 lb.	6.00	— ...
Wood rosin, bbl	280 lb.	6.25	— ...
Spirits of turpentine	gal.	.58	— ...
Wood turpentine steam dist	gal.	.57	— ...
Wood turpentine, dest. dist	gal.	.56	— ...
Pine tar pitch, bbl	200 lb.	...	— 7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	...	— 14.50
Retort tar, bbl	500 lb.	15.00	— 14.75
Rosin oil, first run	gal.	.45	— ...
Rosin oil, second run	gal.	.48	— ...
Rosin oil, third run	gal.	.60	— ...

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.17	— $0.18
Upriver coarse	lb.	.11½	— 12½
Upriver caucho ball	lb.	.14	— 14¼
Plantation—First latex crepe	lb.	.18½	— ...
Ribbed smoked sheets	lb.	.16½	— ...
Brown crepe, thin, clean	lb.	.18	— ...
Amber crepe No. 1	lb.	.20	— ...

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.08½	— $0.09¼
Castor oil, AA, in bbls	lb.	.09½	— .10
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08½	— .08¾
Cocoanut oil, Ceylon grade, in bbls	lb.	.09½	— .10
Cocoanut oil, Cochin grade, in bbls	lb.	.10½	— .10¾
Corn oil, crude, in bbls	lb.	.07½	— .08
Cottonseed oil, crude (f. o. b. mill)	lb.	.03¼	— .04
Cottonseed oil, summer yellow	lb.	.06	— ...
Cottonseed oil, winter yellow	lb.	.06½	— ...
Linseed oil, raw, car lots (domestic)	gal.	.56	— .57
Linseed oil, raw, tank cars (domestic)	gal.	.50	— ...
Linseed oil, in 5-bbl lots (domestic)	gal.	.59	— .60

Olive oil, commercial	gal.	$1.90 —	$2.50
Palm, Lagos	lb.	.07 —	.07¼
Palm, Niger	lb.	.06 —	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.05½ —	.05¾
Peanut oil, refined, in bbls	lb.	.10 —	.10½
Rapeseed oil, refined in bbls	gal.	.90 —	.95
Rapeseed oil, blown, in bbls	gal.	1.00 —	1.05
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07½ —	.07⅝
Soya bean oil, tank cars, f.o.b., Pacific const	lb.	.04¼ —	....
FISH			
Light pressed menhaden	gal.	$0.45 —	$0.47
Yellow bleached menhaden	gal.	.47 —	....
White bleached menhaden	gal.	.49 —	....
Blown menhaden	gal.	.84 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00 —	25.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.07½ —	.08
Graphite, Ceylon chip	lb.	.06 —	.06½
Graphite, high grade amorphous crude	lb.	.02½ —	.03
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.57 —	....
Shellac, orange superfine	lb.	.60 —	....
Shellac, A. C. garnet	lb.	.45 —	....
Shellac, T. N	lb.	.45 —	....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	14.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	35.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh		1,000	160
Carborundum refractory brick, 9 i	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points		net ton	80–100
Chrome cement, 40–45% Cr_2O_3		net ton	45–50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points		net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works		1,000	55–60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works		1,000	45–50
Magnesite brick, 9-in. straight		net ton	90
Magnesite brick, 9-in. arches, wedges and keys		net ton	105
Magnesite brick, soaps and splits		net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district		1,000	45–55
Silica brick, 9-in. sizes, f.o.b. Birmingham district		1,000	45–55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa		1,000	45–55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.15 —	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	85.00 —	90.00
Ferromanganese, 76-80% Mn, English	gross ton	85.00 —	90.00
Spiegeleisen, 18-22% Mn	gross ton	32.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb	2.50 —	....
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	85.00 —	90.00
Ferrosilicon, 75%	gross ton	145.00 —	150.00
Ferrotungsten, 70-80% per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.45 —	.50
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	.45 —	.50
Coke, foundry, f.o.b. ovens	net ton	4.75 —	5.75
Coke, furnace, f.o.b. ovens	net ton	3.75 —	4.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	15.00 —	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico	net ton	17.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.50
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.30 —	.35
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14 —	.15
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14 —	.15
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	.13
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	28.0@28.5
Antimony, wholesale lots, Chinese and Japanese	5¼@5½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35
Monel metal ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	29.25
Lead, New York, spot	4.25@4.35
Lead, E. St. Louis, spot	4.25
Zinc, spot, New York	5.10
Zinc, spot, E. St. Louis	4.60

OTHER METALS

Silver (commercial)	oz.	$0.58½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.50@1.65
Cobalt	lb.	4.00
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00–75.00
Iridium	oz.	250.00@300.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	44.00–45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00
Copper bottoms	27.50
Copper rods	18.75
High brass wire	18.25
High brass rods	15.25
Low brass wire	20.25
Low brass rods	20.25
Brazed brass tubing	29.00
Brazed bronze tubing	34.25
Seamless copper tubing	22.00
Seamless high brass tubing	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire	8.00@8.25	16.50	9.50	9.50
Copper, light and bottoms	7.00@7.50	14.50	9.00	8.50
Lead, heavy	3.25@3.50	7.25	4.00	4.00
Lead, tea	2.15@2.30	5.25	3.00	3.00
Brass, heavy	4.25@4.50	9.50	7.00	10.00
Brass, light	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings	4.00@4.25	9.50	5.50	6.00
Zinc	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$2.50	$3.80	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	2.50	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes	2.50	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands	2.85	4.65	4.22	6.25	....	....	....
Plates, ¼ to 1 in. thick	2.50	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

TEXARKANA—The Southern Acid & Sulphur Co. is planning for the reconstruction of the building of its plant destroyed by fire, April 1, with loss estimated at about $22,000.

Connecticut

SOUTHINGTON — The Peck, Stow & Wilcox Co., manufacturer of tools has plans under way for the erection of three additions to comprise a 1-story hardening building 67 x 180 ft.; 1-story forge shop, 57 x 100 ft.; and 2-story grinding works, 56 x 156 ft. Pierce & Hutton, Southington, are engineers.

NEW HAVEN — The Columbia Enamel Co. is reported to be planning for the rebuilding of the portion of its plant, recently destroyed by fire.

Florida

MIAMI—The Dexter-Geare Corp. has acquired a local site for the erection of a new plant for the manufacture of monolithic concrete tile products, bricks, etc. Plans are being prepared.

Georgia

COVINGTON—Fire, April 8, destroyed a portion of the plant of the Covington Cotton Oil Co., with loss estimated at close to $150,000, including machinery.

Illinois

CENTRALIA — The American Rubber Co., 1526 South Wabash Ave., Chicago, has awarded a contract to the Welch-McCarthy Constr. Co., 56 W. Washington St., Chicago, for the erection of its proposed new 2-story plant at Centralia, 80 x 360 ft., estimated to cost about $150,000 with machinery. A power plant will also be constructed.

ARGO—The Corn Products Refining Co. has resumed operations at its local grinding plant, following a shut-down for several weeks. It is said that work will be resumed at the Pekin (Ill.) plant at an early date.

PEORIA—The United Paperboard Co. is completing plans for the rebuilding of its local plant, recently destroyed by fire. The new factory is estimated to cost about $200,000 with machinery. C. E. Foster is secretary.

Maryland

FROSTBURG — The Big Savage Fire Brick Co. will resume work at once on its expansion program inaugurated in February and later discontinued. The work will include the erection of two brick and steel buildings, 150 x 300 ft. and 150 x 200 ft.; the first will be used for kiln service, storage and other features of operation, and the other for manufacturing purposes. Considerable new machinery and equipment will be installed, including 12 furnaces. The plant, on completion, will occupy about 14 acres of ground. Employment will be given to about 100 extra operatives and it is proposed to increase production by 50,000 firebrick per day. The extension is estimated to cost about $150,000. D. A. Benson is vice-president and treasurer.

BALTIMORE—The Cook-Nut Corp., Purity Bldg., Lexington and Paca Sts., has arranged for a stock issue of $175,000, the proceeds to be used for the erection of its proposed new local plant for the manufacture of lard substitutes, cooking oils, etc. The plant will be located in the Canton section, and will be 4-story, 80 x 100 ft., estimated to cost $125,000. Bids for erection will soon be asked. Walton R. Spruill is president, and John L. Swope, vice-president.

FAIRFIELD—The Prudential Oil Co. has commenced the erection of a number of additions to its plant.

Massachusetts

TAUNTON—The Weir Stove Co. is having plans prepared for the erection of a new 2-story foundry addition on Fourth St., 77 x 77 ft., estimated to cost about $25,000. J. R. Anthony is head.

BOSTON—The American Glue Co., operating a number of plants in New England and in other sections for the manufacture of glue, gelatines, chemicals, etc., has arranged for a note issue of $1,500,000, the proceeds to be used in connection with general operations.

Michigan

BATTLE CREEK—The American Stamping Co., manufacturer of stamped metal products, has awarded a contract to F. B. Cole, Battle Creek, for the erection of its proposed new 1- and 2-story plant, 110 x 225 ft. E. R. Sherman is president.

Minnesota

ST. PAUL — The Northwestern Spring Mfg. Co. is planning for the rebuilding of the portion of its plant, located in the Columbia Heights section, destroyed by fire, March 25, with loss estimated at about $100,000, including equipment.

Nebraska

ANTIOCH — Fire April 2 destroyed a section of the plant of the American Potash Co. with loss estimated at about $500,000 including machinery.

New Jersey

NEWARK—The Zeller Laquer Co., recently organized, has acquired a plant at Irvington, consisting of a number of 1-story buildings on a 3½-acre site, for the establishment of a new plant. The factory aggregates about 28,000 sq.ft. of floor area. The company is headed by Gustav Zeller and Richard Zeller, formerly connected with the Egyptian Lacquer Co., 5 E. 40th St., New York.

TRENTON — The Star Porcelain Co., Muirhead Ave., manufacturer of electrical porcelain specialties, has completed plans for the erection of a 2-story addition 30 x 100 ft. to cost about $10,000. Herbert Sinclair is head.

TRENTON — The Ewing Rubber Co., Homan Ave., is planning for the rebuilding of the portion of its plant recently destroyed by fire.

New York

SYRACUSE — The By-Products Coke Corp., Milton Ave., is planning for a bond issue of $4,000,000 and stock issue of $5,000,000, to be used in connection with general operations.

ITHACA—The Board of Trustees, Cornell University, will soon take bids for the construction of a new 4-story chemical laboratory and instruction building, 70 x 270 ft., to be located at East Ave. and Rockefeller Hall, and estimated to cost about $2,000,000. Gibb & Waltz, 110 North Tioga St., Ithaca, are architects.

BUFFALO—The Williams Gold Refining Co., 2978 Main St., will take bids at an early date for the erection of a 1-story addition, 50 x 60 ft., estimated to cost about $12,000.

North Carolina

HAMLET—The Poole Turpentine Distilling Co. is planning for the erection of a new plant for turpentine and byproducts production.

Ohio

CLEVELAND — The Collinwood Shale Brick & Supply Co. has leased a plant from the Medal Paving Brick Co. for a period of five years, and plans for the operation of the property. The lease begins at a yearly rental of $65,000 and terminates at $100,000.

BRILLIANT — The Crystal Shade Co., Wheeling, W. Va., is planning for the immediate operation of a local glass-manufacturing plant recently acquired. Employment will be given to about 50 men for initial production.

Pennsylvania

PHILADELPHIA — The Federal Container Co. 25th and Locust Sts. manufacturer of corrugated paper containers, etc., has awarded a contract to W. W. Lindsay & Co., Harrison Building, for the erection of a new 2-story plant at 56th St. and Pashall Ave., 82 x 302 ft., estimated to cost about $150,000 with machinery.

PHILADELPHIA — Fire, April 4, destroyed a portion of the fertilizer manufacturing plant of the Savannah Co., 37th and Tasker Sts., with loss estimated at about $12,000.

BANGOR—The Bangor Paper Box Co. will take bids at once for the erection of a new 3-story plant, 35 x 100 ft., estimated to cost about $25,000. M. H. Wheeler is head.

PHILADELPHIA—The Sun Co., Finance Bldg., operating local oil refineries, has arranged for a bond issue to total $6,000,000, to be used in connection with general operations. J. Howard Pew is president.

PHILADELPHIA—The W. J. McCahan Sugar Refining Co., Front and Chestnut Sts., has taken title to property at 101-105 South Front St., for a consideration of $75,000, to be used in connection with its local operations.

Oregon

PORTLAND — The Willamette Iron & Steel Co. has perfected plans for the erection of its proposed new plant on the shipyard property formerly occupied by the Foundation Co. The works will consist of a number of buildings, estimated to cost about $250,000 with machinery. Permits to cover initial features of the project have been issued.

Tennessee

ELIZABETHTON—The Watauga Extract Co. is said to be planning for the rebuilding of the portion of its local plant recently destroyed by fire, with loss estimated at about $15,000.

MEMPHIS — The Missouri Portland Cement Co. will complete a sand and gravel producing plant on Chelsea Ave., and put it into operation within the next sixty days. The plant will be equipped with an electrically-driven steel dredge. Offices are in the Union & Planters Bank Bldg., Memphis.

Texas

SAN ANTONIO—The International Petrolem Co. has awarded a contract to the Southern Steel Construction Co., San Antonio, for the completion of its oil refinery on South Presa St., near the city, recently purchased, in incompleted condition, from the Rogers Refinery. The plant will represent an investment of $100,000, and will have an initial capacity of 1,000 bbls. of crude oil daily.

BRECKENRIDGE—The Consumers' Water & Gas Co., recently incorporated with a capital of $500,000, is considering the erection of a new absorption gasoline plant. E. G. Dawes and O. L. Barr head the company.

TEXARKANA — The Diamond Spear Chemical Co., recently incorporated with a capital of $40,000, will operate a local plant for the manufacture of chemical products. Clifton Spear and B. L. Mahon head the company.

West Virginia

CHARLESTON — The American Clay Products Co. has commenced the erection of a new plant in the vicinity of Teays, W. Va., for the manufacture of hollow tile and other burned clay products. The company recently increased its capital from $5,000 to $50,000 for expansion. C. L. Rice is president and treasurer.

ST. MARYS—The Western Glass Co. is arranging for the early resumption of operations at its plant, following a shut-down of about three months. It is proposed to develop normal output on a gradual scale.

NEW MARTINSVILLE — The Universal Concrete Produces Co. has commenced the construction of a new plant, 70 x 120 ft., for the manufacture of concrete blocks, bricks and kindred specialties.

WHEELING — The Northern Wheeling Bottle Co. will soon resume production at its local plant, giving employment to about 200 men.

Capital Increases, Etc.

THE SHASTA ZINC & COPPER CO., San Francisco, Cal., has filed notice of increase in capital from $20,000,000 to $25,000,000.

THE STANDARD BRICK CO., Charleston, W. Va., has filed notice of increase in capital from $10,000 to $150,000. Fred M. Staunton is president.

THE PEERLESS STAMPING CORP., Ypsilanti, Mich., has filed notice of increase in capital from $10,000 to $60,000.

THE APEX CHEMICAL CO., 61 Park Row, New York, N. Y., has filed notice of increase in capital from $10,000 to $60,000.

THE PRODUCERS' CHEMICAL CORP., 201 B'way, New York, N. Y., has filed notice of dissolution under state laws.

THE HURON CLAY PRODUCTS CO., Croswell, Mich., has filed notice of increase in capital from $50,000 to $70,000.

THE EASTERN OIL REFINING CO., a Delaware corporation, has filed notice of organization to operate in New York with a capital of $5,000,000. E. J. Suor, Buffalo, is corporate representative.

THE AMERICAN PAPER TUBE CO., Woonsocket, R. I., has filed notice of increase in capital from $100,000 to $600,000.

THE BRIGGS CO., Lansing, Mich., manufacturer of brick and other burned clay products, has filed notice of increase in capital from $150,000 to $400,000.

THE D'ARCY SPRING CO., Kalamazoo, Mich., manufacturer of steel springs, etc., has filed notice of increase in capital from $75,000 to $1,000,000.

New Companies

THE SARDONYX MFG. CO., Dallas, Tex., has been incorporated under Delaware laws with a capital of $50,000 to manufacture soaps and kindred products. The incorporators are J. E. Bryant, E. Morley Page, Dallas; and William H. Herring, Houston, Tex.

THE NEW ENGLAND PAPER MILLS, INC., New York, N. Y., has been incorporated with a capital of $25,000 to manufacture paper products. The incorporators are A. Braunstein, J. Hillman and M. Leffert, 198 B'way.

THE MIDDLESEX RUBBER CO., Reading, Mass., has been incorporated with a capital of $50,000 to manufacture rubber products. George E. Jeandheur, 1277 Commonwealth Ave., Brighton, Mass., is president and treasurer; Michael F. Culliney and H. M. Clifford, Reading, are directors.

THE B. L. W. CO., 1542-44 Milwaukee Ave., Chicago, Ill., has been incorporated with a capital of $20,000 to manufacture leather goods. The incorporators are Louis Winkler, David Berger and Samuel La Bow.

THE STILLWATER PAPER MILLS, INC., Stillwater, Pa., has been incorporated with a capital of $10,000 to manufacture paper goods. F. N. Hamlin is treasurer.

THE ADRIAN CHEMICAL CO., Pittsburgh, Pa., has been incorporated with a capital of $25,000 to manufacture chemicals and chemical byproducts. The incorporators are R. D. King, F. M. Adrian and George H. Wood, Pittsburgh.

THE FALCO CHEMICAL CORP., Buffalo, N. Y., has been incorporated with a capital of $10,000 to manufacture chemicals and kindred products. The incorporators are T. Locon, F. H. Cofail and S. B. Pfeifer, Buffalo.

THE TIDEWATER GLASS CO., Wheeling, W. Va., has been incorporated with a capital of $250,000 to manufacture glass products. The incorporators are George A. Blackford, and A. Seamon, Wheeling; and A. J. Gilleland, Martins Ferry, O.

THE WARREN BRICK & TILE CO., Detroit, Mich., has been incorporated with a capital of $100,000 to manufacture brick, tile and other burned clay products. The incorporators are Abraham Budnitzky, Abraham Nordoloff and Louis Chernoff, 80 Glendale Ave.

THE PARIS PAPER BOX CO., Boston, Mass., has been incorporated with a capital of $25,000 to manufacture paper containers and kindred products. The incorporators are I. Mochedlover, Benjamin Nigrosh and Max Nigrosh, 183 Walnut St., Roxbury, Mass.

THE LEVIATHAN OIL CORP., Lockport, N. Y., has been incorporated with a capital of $250,000 to manufacture refined oil products. The incorporators are A. A. Gloetzner, A. E. Lee and R. R. Singer, Lee, Ward & Riley, F. & M. Bank Bldg., represent the company.

THE AMERICAN PHOSPHATE CORP., New York, N. Y., has been incorporated with a capital of $5,000 to manufacture fertilizers and kindred products. The incorporators are P. J. Dobson, L. N. Martin and W. J. Eldredge. Foley & Martin, 64 Wall St., represent the company.

THE INTER-OCEAN PAPER & BAG CO., 350 North Clark St., Chicago, Ill., has been incorporated with a capital of $30,000 to manufacture paper products. The incorporators are Edward J. Sexauer, Samuel J. Howe and Bernhardt J. Ness.

THE SERVICE HEAT-TREATING CO., Detroit, Mich., has been incorporated with a capital of $5,000 to manufacture heat-treating equipment for steel and other metals. The incorporators are Herbert F. Halpin, Robert Barker and Charles Reinacker, 2243 Hilliger Ave.

THE NATIONAL CHINA CO., Huntington, W. Va., has been incorporated with a capital of $10,000 to manufacture chinaware products. The incorporators are S. Heimy, L. Leibovitz and L. Slutsky, Huntington.

THE EL GOBIERNO PETROLEUM CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are Norman Bridge, J. C. Anderson and Olin Wellborn, Jr., Los Angeles.

GREENWALD BROS., INC., New York, N. Y., has been incorporated with a capital of $6,000 to manufacture chemicals and affiliated products. The incorporators are M. Greenwald, E. S. Rifkin and A. Leichter, 141 B'way.

A. LUSSKIN, INC., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture chemicals and chemical byproducts. The incorporators are A. Lusskin, I. H. Kessler and I. Miller. H. A. Harkavy, 299 B'way., represents the company.

THE NASHVILLE ENAMELING CO., 42d Ave. and Charlotte Pike, Nashville, Tenn., has been incorporated with a capital of $50,000 to manufacture enamelware products. The incorporators are Valentine Taylor, John R. Burrows and Herman Spitz, Nashville.

THE DETROIT POROUS INNER TUBE CO., Hamtramck, Mich., has been incorporated with a capital of $100,000 to manufacture automobile tubing, rubber mats and other rubber products. The incorporators are Frank Moons and George S. Holstein, 3128 Elmwood Ave., Detroit.

THE GARDNER PAPER CO., Providence, R. I., has been incorporated with a capital of $100,000 to manufacture paper products. The incorporators are LeRoy N. Gardner and Albert A. Adams, Providence.

THE AURORA STEEL & STAMPING CO., 375 High St., Aurora, Ill., has been incorporated with a capital of $25,000 to manufacture steel and other stamped metal products. The incorporators are Benjamin P. Alschuler, Ralph C. Putnam and Glenn T. Johnson.

THE DUNMORE DRUG MFG. CO., Dunmore, Pa., has been incorporated with a capital of $40,000 to manufacture chemicals, drugs and affiliated products. The incorporators are M. J. Dempsey, W. B. Weisberger and John J. Byrne, Dunmore.

THE STANDARD SHALE CHEMICAL CO., Columbus, O., has been incorporated with a capital of $10,000,000 under Delaware laws to manufacture chemicals and byproducts. The incorporators are Selden D. Maddox, Columbus; W. E. Tochey, Middletown, O., and Louis M. Day, Chillicothe, O.

THE JET OIL CO., Los Angeles, Cal., has been incorporated with a capital of $250,000 to manufacture petroleum products. The incorporators are W. A. Brophy and S. W. Warrington, Los Angeles; and J. G. Burgess, San Diego, Cal. H. P. Goodwin, 233 Title Insurance Bldg., represents the company.

THE PENETRO CHEMICAL CO., Atlantic City, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Thomas J. and Raymond J. McCaffrey, and John B. Heon. Dr. L. H. English, 130 South Maryland Ave., represents the company.

THE R. & W. PAPER BOX CO., New York, N. Y., has been incorporated with a capital of $5,000 to manufacutre paper boxes and containers. The incorporators are R. H. Blum, E. Kaplan and A. Feldman, 283 Division St.

THE CHEBOYGAN TILE & BRICK CO., Cheboygan, Mich., has been incorporated with a capital of $75,000 to manufacture brick, tile and other burned clay products. The incorporators are W. L. Hagadorn, A. M. Gerow and J. H. Clune, Cheboygan.

THE HUNTINGTON NATIONAL OIL CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are S. C., J. R. and M. D. Woodward, and C. C. Closson, Los Angeles.

THE CAIRO COTTON OIL MILL, INC., Upper Sycamore St., Cairo, Ill., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture oil products. The incorporators are M. L. and F. P. Fox, and F. L. Short.

THE CARAMEL COLOR CO. OF AMERICA, INC., Brooklyn, N. Y., has been incorporated with a capital of $5,000 to manufacture chemicals, colors and affiliated products. The incorporators are R. Adler, B. Levine and A. S. Fischer, 3957 W. 7th St.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY will hold its annual meeting April 27 to 30 in the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon, April 26, at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.